Haines Junction Community Wildfire Protection Plan

Wildland Fire Management

Yukon

Adoption of the Haines Junction Community Wildfire Protection Plan

The Haines Junction CWPP was developed between 2020-2022 and represents a collaborative effort between the Champagne and Aishihik First Nations, Village of Haines Junction, and Government of Yukon to take action to address the threat of wildland fire to the community of Haines Junction. As directed by this CWPP, extensive fuels reduction and wildfire prevention and mitigation activities will be completed on public and Settlement Lands in and around Haines Junction.

This plan is intended to serve as a planning tool for fire and land managers and residents to assess risks associated with wildland fire, identify strategies, and make and implement recommendations for reducing those risks.

Melina Hougen
Director of Heritage, Lands & Resources
Champagne and Aishihik First Nations

October 27, 2022
Date

Tracy Thomas
Chief Administrative Officer
Village of Haines Junction

Nov 15, 2022
Date

Lisa Walker
Director, Wildland Fire Management Branch
Government of Yukon

Nov 15, 2022.
Date

HAINES JUNCTION COMMUNITY WILDFIRE PROTECTION PLAN

Presented to

Wildland Fire Management, Department of Community Services
Government of Yukon

Prepared by

Fortitude Consulting

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Disclaimer

This Haines Junction Community Wildfire Protection Plan was prepared using the best available knowledge and local expertise, within the limits of time and funding constraints allowed for the project. Fortitude Consulting and its author do not warrant or guarantee the accuracy or completeness of the information, statements and opinions expressed in this report, and do not assume any liability with respect to damage or loss incurred as a result of the use made of the information, statements or opinions contained in this document.

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1. Introduction

The intent of the Haines Junction Community Wildfire Protection Plan (CWPP) is to serve the community of Haines Junction as an informative and strategic tool that provides guidance on the challenges, risks and opportunities surrounding the protection of community values from wildfire.

There are some unique factors that influence the climate and fuel hazards in the Haines Junction area relative to other Yukon communities that consequently impact wildfire management and planning. These factors can be summarized as the climatic influence of the Kluane Icefields and the St. Elias Range; the spruce bark beetle epidemic (c.2004), which resulted in a significant and unprecedented volume of dead wood; and a substantial increase in the incidence of lightning. The area is also subject to a large body of relevant research, particularly on the related topics of the impacts of the spruce bark beetle epidemic, and wildfire history and dynamics.

The CWPP contains key information to support impactful wildfire management planning and implementation. Key areas of focus within the CWPP are organised as follows: Section 2 ‘Planning Area’ provides a description of the environmental and ecological systems that influence wildfire dynamics and risk and the role that natural disturbance and forest succession plays. Section 3 ‘Risk Assessment’ summarizes the main source of wildfire risks and fuel hazards, and characterizes the influencing factors that contribute to this risk. An identification of community values most vulnerable to wildfire is also included. Section 4 ‘Risk Management’ is a core component of the CWPP and describes the collaboration between agencies in their response to fire and the capacity of those agencies to respond to wildfire both within the CWPP Planning Area and in the adjacent area. Different types of fuel treatments are described, which can be considered as the tools available to wildfire managers to minimize and mitigate community risk. The potential for physical structures to ignite is incorporated with the intent to raise awareness of this issue and of how individual property owners may play their part in reducing fire risk within the community. Measures to reduce ignition from occurring, including FireSmart principles are also described. Given the recent increase in wildfires in western and northern Canada in recent years, particularly the intensity of some fires and their associated damage to life and property, relatable examples to the Haines Junction context are presented.

CWPP Objectives

Managing for fire risk in a community protection setting requires a balance of priorities. The core objectives of the CWPP are to:

- Collaborate with partners on reducing the risk of wildfire impacts to the community;
- Identify and prioritize fuel treatments in order to reduce fuel areas within and around Haines Junction in order to support community safety through hazard reduction;
- Develop measures that are actionable and achievable to reduce risk;
- Recommend and support strategies to reduce structural ignitability.

2. Planning Area

Haines Junction

The community of Haines Junction is located at the intersection of the Alaska Highway and the Haines Highway. It covers 34 square kilometres within its municipal boundary. Lying adjacent to Kluane National Park and Reserve, the Dezadeash River borders the community to the south and west. Pine Lake is situated north of the community. Haines Junction is a small community adjoining a vast wilderness area that extends into British Columbia and Alaska (refer to Figure 2). Haines Junction has a population of greater than 1,000 people (YBS 2022), though it serves a larger population on its periphery. The community provides the transportation corridor to access the Yukon's northwesterly communities (Silver City, Destruction Bay, Burwash Landing and Beaver Creek; combined population of approximately 300). It is also the junction between interior Alaska to the north and coastal Alaska to the west, via the Haines Highway. It was a strategic location during the construction of the Alaska Highway (1942 to 1943). The highway construction was a major influence on the development of Haines Junction as a permanent settlement. It is located 150 kilometres west of Whitehorse on the Alaska Highway. It is located on the traditional territory of Champagne and Aishihik First Nations. Its original name is Dakwäkäda translates to 'high cache' in the Southern Tutchone language.

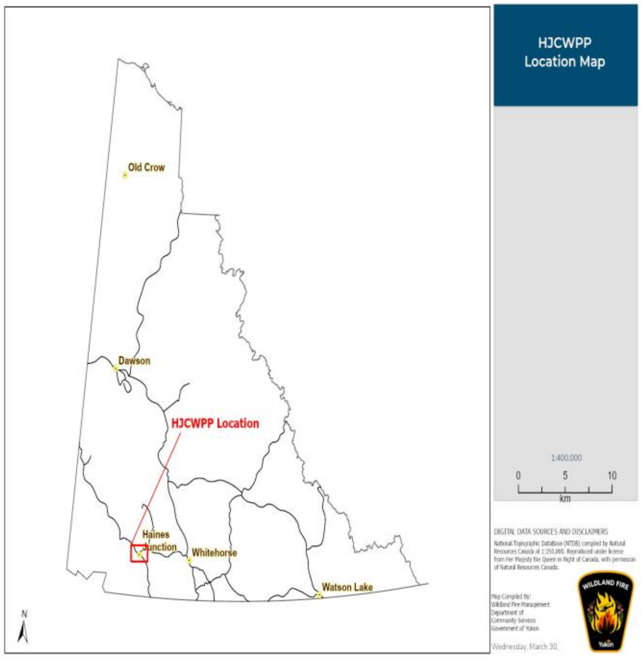

Figure 2. Haines Junction Location

The planning area incorporates Haines Junction and the nearby subdivisions of Nygren, Pine Lake and Paint Mountain, and Bearberry. Refer to Figure 2 above for their location and proximity to Haines Junction.

Ecological Description

Climate and Topography

Haines Junction lies within the Ruby Range Ecozone which is characterized by short, warm summers and long, cold winters. The climate is typically dry and the St. Elias Mountains and Kluane Icefields of Kluane National Park and Reserve (KNPR) have a strong influence over climate conditions, including the low rainfall in summer and an historically low incidence of lightning. The dominant wind direction is southwesterly. Local wind patterns are strongly influenced by the effects of the Icefields, extreme topography, and valley orientation and elevation (Francis 1996; Smith et al 2002).

Vegetation

White spruce (*Picea glauca*) is the dominant species in the area. In Haines Junction, as elsewhere in southwest Yukon, the main deciduous species are trembling aspen (*Populus tremuloides*, often locally referred to as 'poplar') and balsalm poplar (*Populus balsamifera*). Willow (*Salix spp.*) and dwarf birch meadows are present in wetter areas. Soapberry and grasses occupy drier sites (Smith et al 2002). Much of the white spruce stands are mature, with a closed, continuous canopy and a dense, even-aged composition (Hawkes et al 2014). Soils were developed on glacial material and the organic soil horizon is commonly an alkaline, glacial silt-based clay profile.

Natural Disturbance and Forest Succession

Fire and Forest Succession

White spruce is a species that is typically renewed as a result of fire. A crown, surface or ground fire will usually cause a stand (forest) replacement. The establishment of white spruce following a fire will depend on the availability of seed and the cycle of seed dispersal (referred to as 'masting'), seedbed conditions and the intensity of a fire. Particularly intense fires can burn off the organic layer of soil that white spruce (and other vegetation) requires for regeneration, which further delays the conditions white spruce requires to regenerate. Indeed, if fires occur in the same location within a short enough interval, so as to prevent white spruce from regenerating adequately to produce cones, there is the risk that white spruce forests will be replaced by another species altogether. Boreal forests are particularly vulnerable to this phenomenon. The presence of glacial silt from Lake Alsek may even further delay regeneration by an additional 30 to 40 years, as described below. If another stand-replacing fire occurs before this cycle is complete (ie. less than 80 years), there exists the risk of white spruce losing its ability to regenerate naturally, particularly in large patches further from cones in adjacent, intact forest. There are implications for fire management and for managing other values on the landscape, such as wildlife habitat, if swathes of white spruce are permanently replaced with a deciduous species, such as trembling aspen, or if lodgepole pine continues its expansion north and westward. At the interface of community and wilderness zones, the composition of tree species for ecosystem function and other purposes is a lower priority than protecting community values. Put another way, the primary value in an interface zone is protecting community values rather than ecosystem function. The replacement of white spruce by trembling aspen is, in fact, a fuel treatment that will be discussed in this document under 'Prioritised Fuel Treatments.'

‘...the primary value in an interface zone is protecting community values rather than ecosystem function.’

At a landscape level, white spruce will be present in a mosaic of burned patches that includes stand replacements and unburned patches. While many fires in white spruce forests are small, the large fires that take place in extreme fire years account for most of the area burned.

Wildfire suppression across the region and within Kluane National Park and Reserve has likely contributed to a deficit of fire in the Kluane landscape. Fire history shows that 100 to 550 hectares would have burned each year within KNPR[1]. However, within the last 50 years, a total of 380 hectares has burned. The fire deficit (and a reduction in mosaic of age classes) has likely been an influencing factor on the conditions that supported the spruce bark beetle infestation. Fire suppression in British Columbia and Alberta over the last 50 years, for example, has been a major contributing factor to the outbreak of the mountain pine beetle, in addition to the warmer temperatures that do not sufficiently winter kill beetle larvae along.

The ecological monitoring program within Kluane National Park and Reserve collected some initial observable trends in post-beetle forest composition and structure within the park. The program reports that snowshoe hare browse of spruce saplings has resulted in up to 30% mortality in some areas (Wong 2017). The lower performance in white spruce regeneration indicates there is insufficient stocking of white spruce to achieve historical rates (Wong 2017). That is, there are fewer white spruce trees regrowing than there were in the past.

Other Disturbance and Forest Succession

While fire is the most common cause of stand replacement in the Shakwak Trench and the Alsek Valley, another natural disturbance has impacted the local forest. The development of two large lakes and subsequent floods, one as recently as c.1850, were caused by the Lowell Glacier damming the Alsek River, resulting in Great Lake Alsek (also known as Neoglacial Lake Alsek) (Garbutt et al 2006).

Lake Alsek has formed this way several times over the last 500 years. The most recent formation of Lake Alsek was approximately 200 metres wide and 100 kilometres long, extending past the St. Elias Mountains into the Dezadeash River Valley into present day Haines Junction. Based on measurements taken in 1979, the present age of the forests (in

1 Carmen Wong, Ecologist Team Leader, Yukon Field Unit, Parks Canada, Personal Communication.

2022) around Haines Junction that are lower than 595 metres would be approximately 125 years old (refer to Figure 26 in Appendix C for a display of the two most recent natural disturbances in Haines Junction: the location of the c.1850 Lake Alsek and the 1929 fire).

Regeneration of white spruce in Yukon's boreal forest typically begins at least 20 years after a disturbance event. The 20-year lapse is attributed to the need for white spruce to have certain seedbed conditions met before germination can begin. Trembling aspen is the first tree species to quickly regenerate after a natural disturbance and is considered a 'pioneering' tree species that fixes nitrogen to the soil. However, the regeneration of white spruce following Lake Alsek is reported to be considerably longer. The delay of white spruce is thought to be 40 to 60 years and is due to the low soil profile attributed to silt and clay deposits from previous Lake Alsek events (Kindle 1952 in Clague and Rampton 1982). This considerable delay is consistent with reports of oral history that grasses dominated the valley after the 1850 flood before eventually transitioning to spruce (Garbutt et al 2006). A stand-replacing fire in the same location as Lake Alsek may result in a considerable delay for white spruce forest to return around Haines Junction's westerly perimeter.

Fire Regime

Canada's northwest boreal forest is known as a fire-adapted ecosystem. The dominant tree species (conifers) rely on stand-replacing events such as wildfire in order to regenerate. Boreal landscapes are dominated by conifers that cover large tracts of land and provide ample and relatively continuous fuels in the event of a fire. A boreal climate typically has low precipitation with lightning as a key cause of fire ignitions. These factors combined contribute to conditions conducive to intense, landscape-scale fires that cover large areas.

Boreal wildfires have an elevated risk in spring, in advance of green-up, and again in summer as the fuels dry up during periods of sustained heat. The tendency for boreal forests to support high-intensity crown fires renders them a hazard when they burn in proximity to communities (Beverly et al 2021). It is the crown fires of wind-driven, high intensity that are often large-scale and capable of igniting spot fires from ember transport several kilometres in advance of the main fire (Westhaver 2017).

There are three general categories of fire behaviour and each is a product of forest fuels, weather and climate.

i) Surface Fire

These fires burn fuels along the forest floor including the duff layer, leaf litter and woody debris. Although the rate of spread can be highly variable, the intensity of most surface fires in boreal forests is within the capability of firefighters to control.

ii) Crown Fire
A crown fire burns the canopy of a forest and often all the layers of forest structure to ground level. This type of fire can consume most of the vegetation and woody debris in a forest. Crown fires are known for their intensity, a faster rate of spread and their tendency to burn uncontrollably. Spruce forests are particularly susceptible to crown fires due to the presence of ladder fuels that virtually extend to the forest floor.

iii) Ground Fire
A ground fire burns slowly in the duff layer and tree roots underground, but can transition to an above ground (surface) fire under the right conditions. A ground fire can burn below the frost line in winter and reignite in the following spring or summer.

Reducing the ability of a fire to transition from surface to a crown fire is a critical component in the protection of a community from the worst effects of wildfire. In the Haines Junction context, the laddering of fuels caused by decaying beetle-killed spruce further contributes to the development of a crown fire.

WILDLAND FIRE TYPES

Figure 3. Wildland Fire Types. (Source: Adapted from Government of Ontario.)

Fire Spread Patterns

The Shakwak Trench is a 65-kilometre long valley that trends in a northwest direction and has Haines Junction at its southern end. The valley averages 11 kilometres in width and is situated between the Kluane and Ruby Ranges (Smith et al 2002). A section of the Alaska Highway runs though the bottom of the Trench north of Haines Junction. Topography, wind dynamics and vegetation are strong influencing factors in fire spread patterns for Haines Junction, particularly under extreme fire conditions. The Trench is located in the path of the prevailing southwesterly wind that would direct the typical trajectory of a forest fire towards Haines Junction. Large valleys perpendicular to the Shakwak Trench (Alsek, Slims and Jarvis Valleys) funnel katabatic[2] and glacial winds that can cause brief but intense windstorms (Francis 1996). The Alsek Valley, as elsewhere described, has been subject to heavy spruce beetle attack and, as a result, has a higher proportion of flammable fuels contributed by the high mortality of dead spruce. It therefore presents a higher fire risk. These strong wind events may be important considerations during a fire event in the area, particularly under extreme conditions. Refer to Figure 4 for a display of wind patterns influencing Haines Junction.

2 A katabatic wind is considered a drainage wind that carries high-density air downward using the force of gravity. High-density cold air can develop over ice sheets, such as those in the Kluane Icefields.

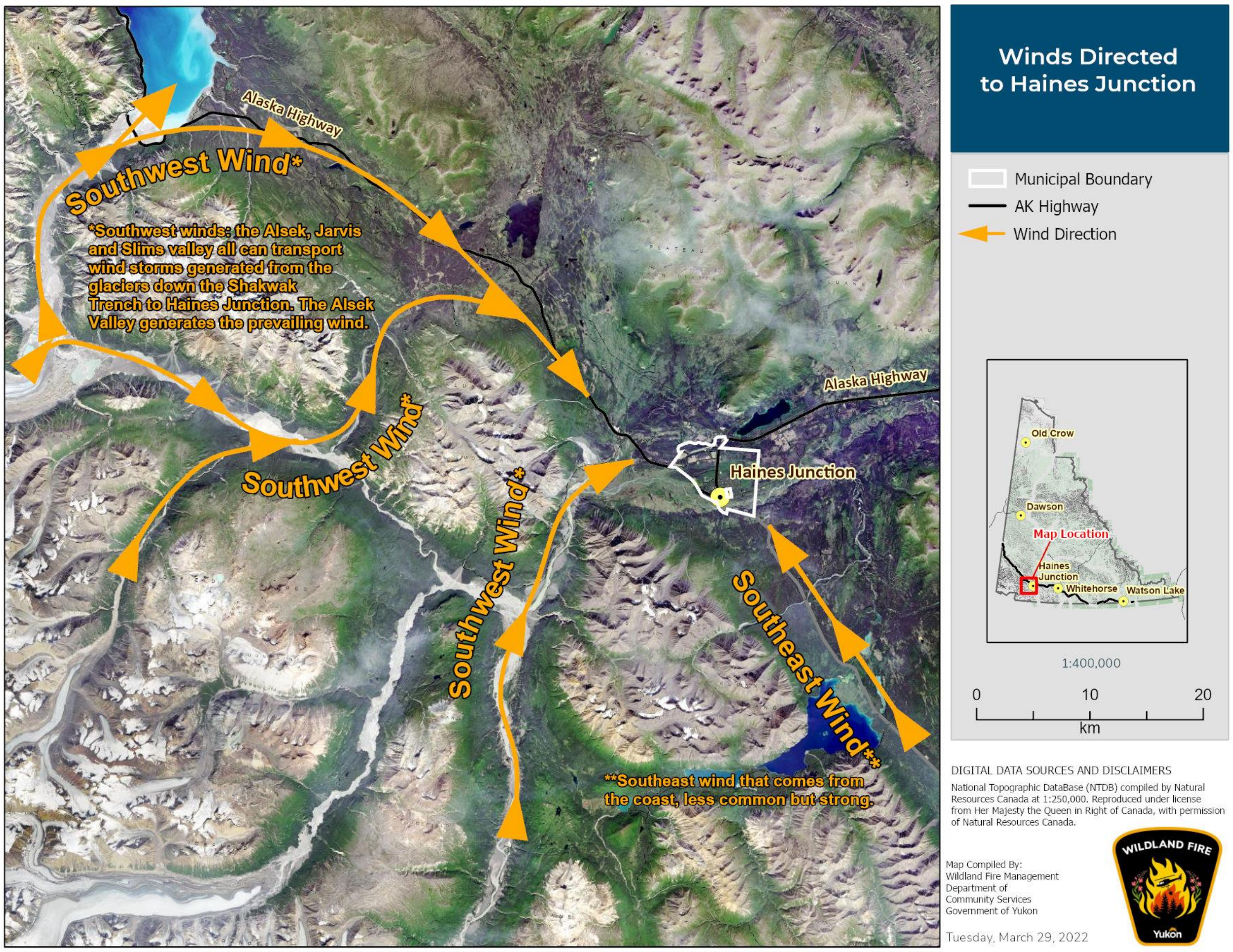

Figure 4. Winds Directed to Haines Junction

Risk Assessment

Wildland Fire Management (Yukon Government) took the lead role in the planning and development of the CWPP. Fortitude Consulting, based in Haines Junction, was hired to write the CWPP and provide technical expertise. Opportunities for collaboration and input were provided to Kluane National Park and Reserve (Government of Canada), the Alsek Renewable Resource Council, Champagne and Aishihik First Nations (CAFN) and the Village of Haines Junction as part of the Haines Junction Forest Fuels Management Working Group. The public was also invited to review and provide input into the CWPP in April 2020. The CWPP benefited from the input provided by all of these parties.

Some of the work and planning carried out for fuel abatement since that time stems from the risks identified through the 2008 Haines Junction Community Fuel Abatement Plan (CFAP).

Fire risk was identified as a priority in the development of the Strategic Forest Management Plan for the Champagne and Aishihik Traditional Territory. In response, from 2007 to 2008, the Wildland Fire Management Branch, the Forest Management Branch (YG), and Champagne and Aishihik First Nations worked together to assess fire risks for Haines Junction and develop the Haines Junction Community Fuel Abatement Plan (YG 2008). The group identified zones for Haines Junction into priority areas for timber harvesting and fuel abatement. Refer to Figure 5 for an overview of the fuel abatement areas identified in the Risk Management section.

Fuel Types and Hazards

The beetle-killed spruce forest in the Haines Junction area presents an unusually high potential for fire severity and spread. Dead spruce trees are more likely to ignite from embers and to spread more embers once they burn. The volume of dry fuel, both standing and on the surface, is higher in a spruce beetle-affected forest. These factors complicate the fuel classification for Haines Junction. Standard typing models do not adequately describe these conditions.

The Canadian Forest Service (Natural Resources Canada) has developed a nation-wide Canadian Wildland Fire Information System (WFIS) that is used for classification and prediction by land managers, wildfire planning and researchers to better understand and prepare for fires. Nested within the WFIS is a suite of fire weather, fire behaviour, modelling and prediction tools. One of these is the Canadian Forest Fire Behaviour Prediction (FBP) System. This provides estimates for different parameters that will influence the impact of a fire, such as the potential for it to consume fuels, the potential for the fire front to spread, fire intensity, and descriptions of fire types and behaviour. Incorporated into the FBP are fuel type descriptions. These descriptions consider forests from the perspective of fuels in a fire risk context. For southwest Yukon, the dominant fuel type is C2.

C2 – Boreal spruce

This fuel type is characterized by pure, moderately well-stocked black spruce (Picea mariana (Mill.) B.S.P.) stands on lowland (excluding Sphagnum bogs) and upland sites. Tree crowns extend to or near the ground. Dead branches are typically draped with bearded lichens (Usnea spp.). The flaky nature of the bark on the lower portion of stem boles is pronounced. Low to moderate volumes of down woody material are present. Labrador tea (Ledum groenlandicum Oeder) is often the major shrub component. The forest floor is dominated by a carpet of feather mosses and/or ground-dwelling lichens (chiefly Cladonia). Sphagnum mosses may occasionally be present, but they are of little hindrance to surface fire spread. A compacted organic layer commonly exceeds a depth of 20 to 30 cm[3].

The C2 description lists black spruce as the main species. However, white spruce is the dominant species. The C2 description is otherwise the most accurate for the forest/fuel type around Haines Junction. Other relevant fuel types include M2 and D1. M2 (75%) is present in and around Haines Junction where the 1929 fire burned.

M2 - Boreal Mixedwood–Green

This fuel type is characterized by stand mixtures consisting of the following coniferous and deciduous tree species in varying proportions: black spruce (Picea mariana (Mill.) B.S.P.), white spruce (Picea glauca (Moench) Voss), balsam fir (Abies balsamea (L.) Mill.), subalpine fir (Abies lasiocarpa (Hook.) Nutt.), trembling aspen (Populus tremuloides Michx.) and white birch (Betula papyrifera Marsh.). On any specific site, individual species can be present or absent from the mixture. In addition to the diversity in species composition, stands exhibit wide variability in structure and development, but are generally confined to moderately well-drained upland sites. M2, the second phase of seasonal variation in flammability, occurs during the summer. The rate of spread is weighted according to the proportion (expressed as a percentage) of softwood and hardwood components. D1 is the leafless version of M2 and is present

3 https://cwfis.cfs.nrcan.gc.ca/background/fueltypes/c2

during spring and fall. (Source: as above). M2 25% and M75% on the Fuel Hazard Maps refer to the percentage of conifers in the composition.

D1 - Leafless Aspen

This fuel type is characterized by pure, semi-mature trembling aspen (Populus tremuloides Michx.) stands before bud break in the spring or following leaf fall and curing of the lesser vegetation in the autumn. A conifer understory is noticeably absent, but a well-developed medium to tall shrub layer is typically present. Dead and down roundwood fuels are a minor component of the fuel complex. The principal fire-carrying surface fuel consists chiefly of deciduous leaf litter and cured herbaceous material that is directly exposed to wind and solar radiation. (Source: as above).

Deciduous Trees

Aspen in full leaf, conversely, is considered a less flammable fuel type than white spruce. For that reason, the replacement of conifers (such as white spruce) by trembling aspen is designed as a treatment to reduce fire risk adjacent to communities. In 2015, a small area of white spruce south of Haines Junction was intentionally converted to aspen by planting for this purpose (refer to Figure 5) below for the location of the spruce to aspen conversion). A large proportion of Haines Junction is an aspen forest that is transitioning back to white spruce. The Haines Junction Community Fuel Abatement Plan (YG 2008) identified this as area that 'will not need treating' because 'the aspen form a fire break of inflammable material to contain a fire' (YG 2008). However, as the understory of white spruce continues to mature, the previous classification of this area as being low-risk will require further risk assessment.

Less prevalent in the planning area are these fuel types:

O1 – Grass

This fuel type is characterized by continuous grass cover, with no more than occasional trees or shrub clumps that do not appreciably affect fire behaviour. Two sub-type designations are available for grasslands; one for the matted grass condition common after snowmelt or in the spring (O1-a) and the other for standing dead grass common in late summer to early fall (O1-b). The proportion of cured or dead material in grasslands has a pronounced effect on fire spread there and must be estimated with care.

C1 - Spruce–Lichen Woodland

This fuel type is characterized by open, parklike black spruce (Picea mariana (Mill.) B.S.P.) stands occupying well-drained uplands in the sub-Arctic zone of western and northern Canada. Jack pine (Pinus banksiana Lamb.) and white birch (Betula papyrifera Marsh.) are minor associates in the overstory. Forest cover occurs as widely spaced individuals and dense clumps. Tree heights vary considerably, but bole branches (live and dead) uniformly extend to the forest floor. Layering development is extensive. Accumulation of woody surface fuel is very light and scattered. Shrub cover is exceedingly sparse. The ground surface is fully exposed to the sun and covered by a nearly continuous mat of reindeer lichens (Cladonia spp.), averaging 3 to 4 centimetres in depth above mineral soil.

Spruce Bark Beetle Epidemic Distribution and Forestry Fuel Abatement

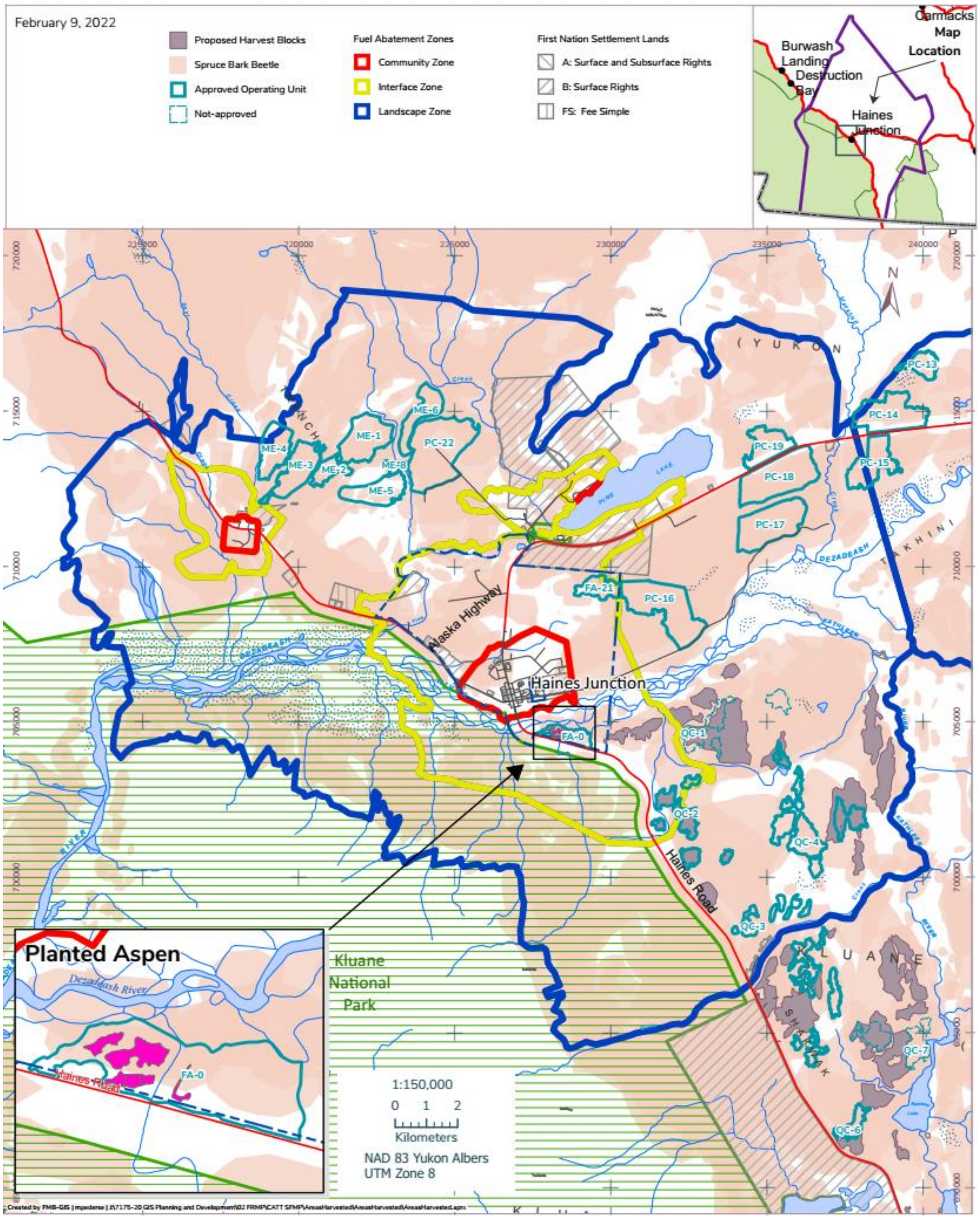

Figure 5. 'FMB Map' of spruce bark beetle-affected forest; Fuel conversion treatment (2015 aspen plant), Proposed timber harvest blocks; Haines Junction Community Fuel Abatement Plan (2008) zones. Map care of the Forest Management Branch, EMR and Wildland Fire Management, CS, YG.

Fuel Hazard Mapping

Haines Junction is directly surrounded by an aspen spruce mix that is transitioning to a spruce-dominated forest (M2). The following is a series of fuel hazard maps that identify fuel types in key areas around the community. As described, C2 is the classification for dead white spruce. It represents the most flammable fuel type on the landscape.

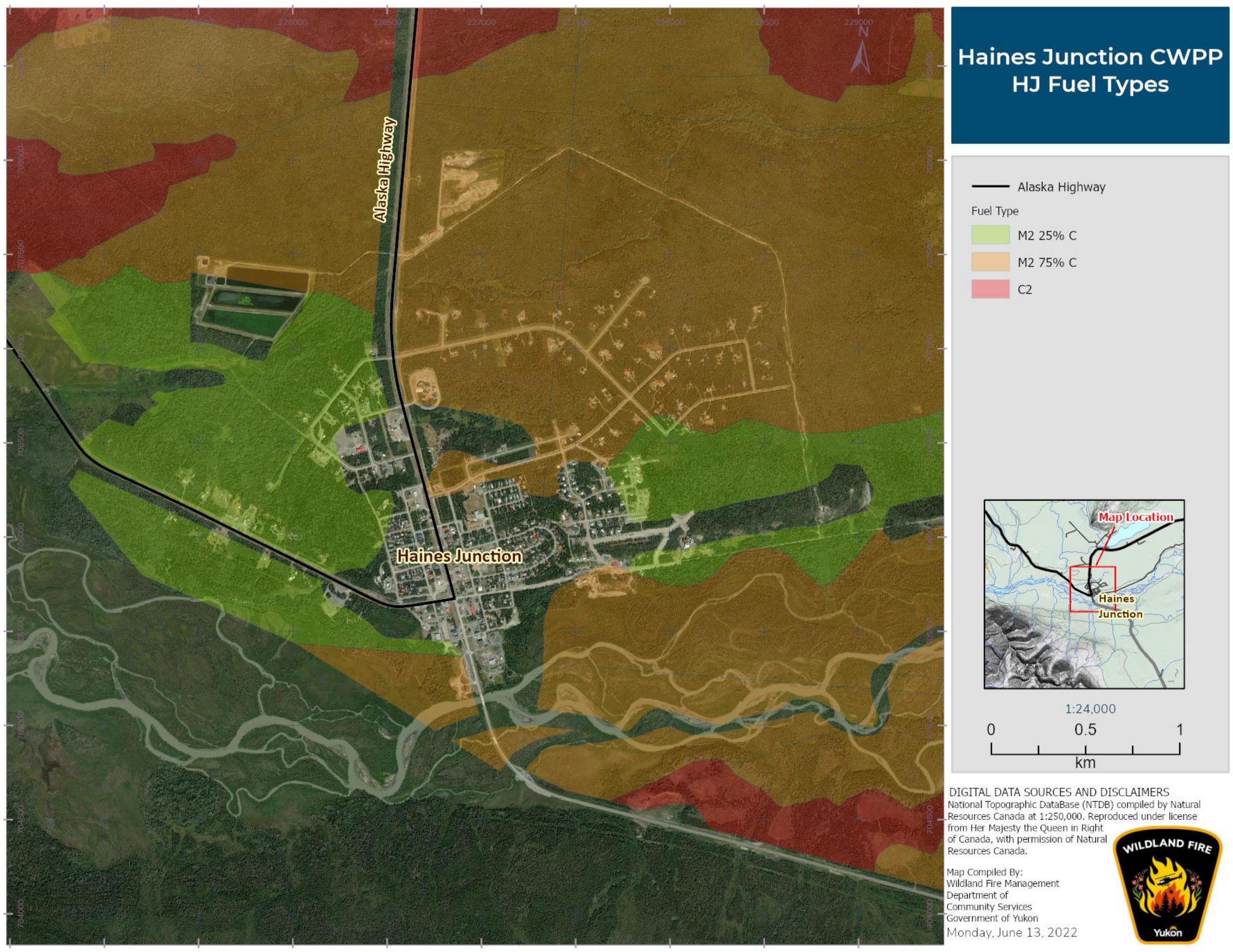

Figure 6. Haines Junction Fuel Types

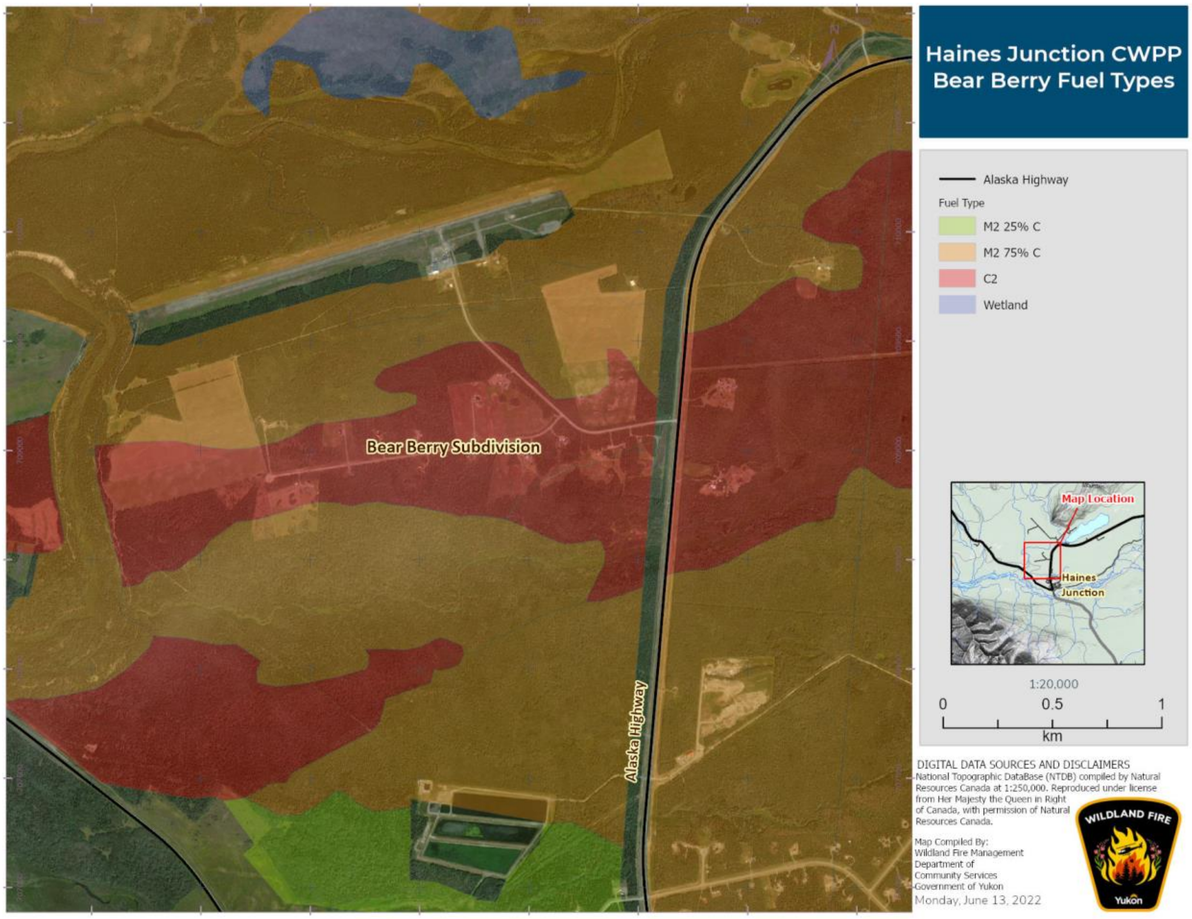

Figure 7. Bear Berry Subdivision Fuel Types

The Bear Berry subdivision, northwest of Haines Junction's core area, has a high proportion of over mature spruce forest.

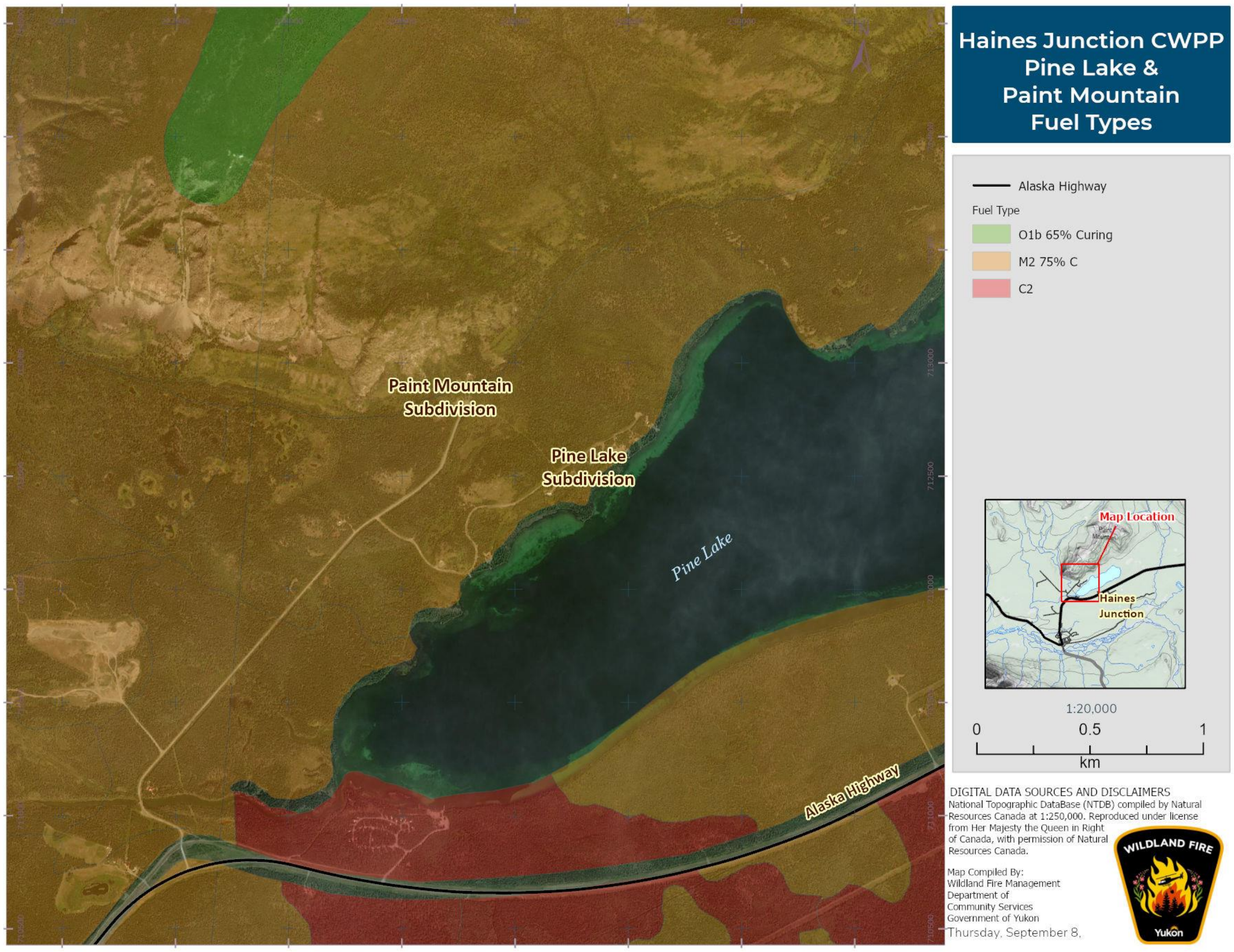

Figure 8. Pine Lake and Paint Mountain Subdivision Fuel Types

The Pine Lake subdivision is located in the direct path of two of the last three large fires in the area. There are stretches of white spruce forest to the southwest, in the path of the prevailing wind.

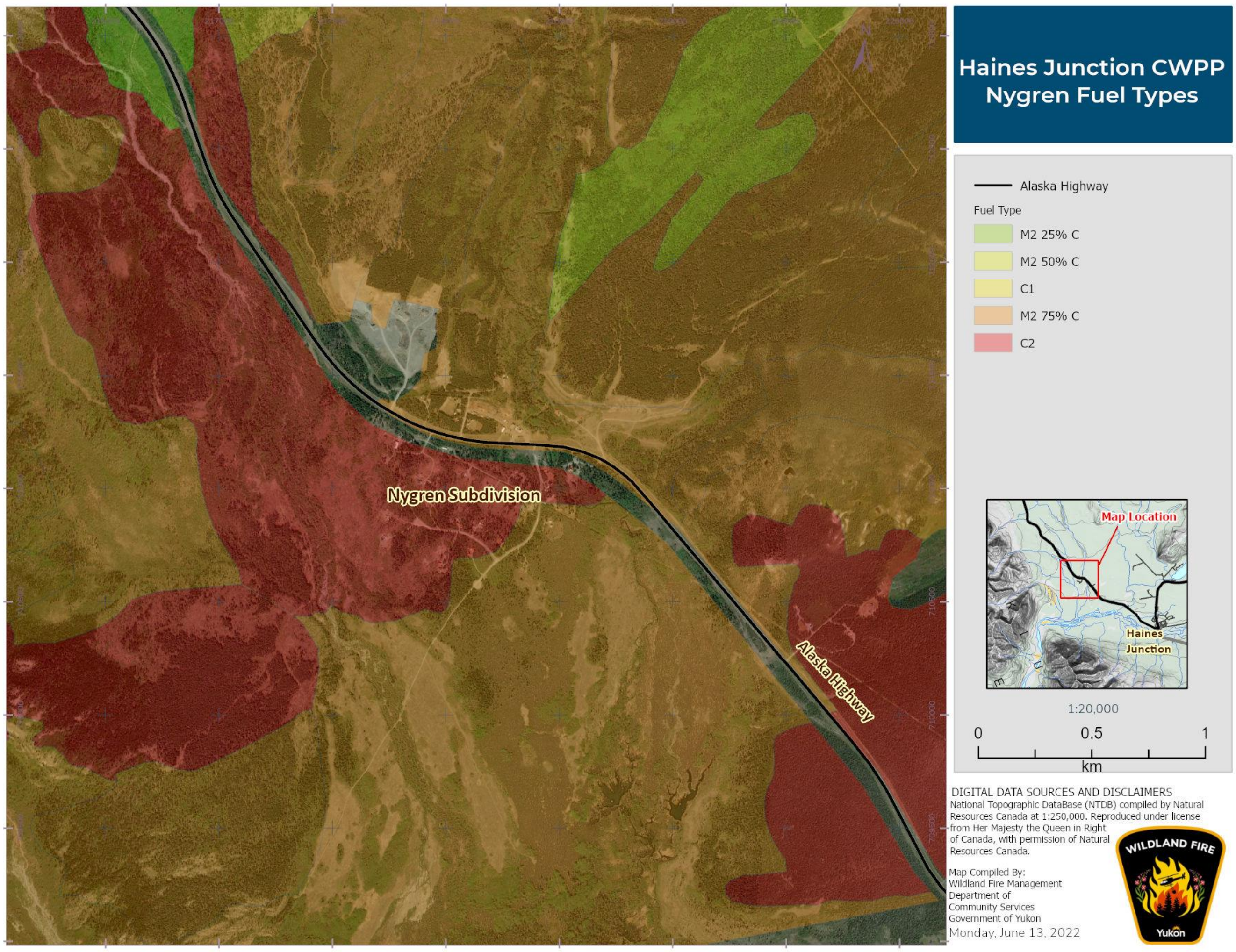

Figure 9. Nygren Subdivision Fuel Types

Nygren Subdivision is more directly impacted by Alsek Valley winds and is close to a high proportion of beetle-killed spruce.

Fire Suppression

Fire suppression, while protecting values at risk in the short-term, does have the undesired long-term effect of contributing to the volume and extent of flammable fuels adjacent to communities. Put another way, putting out fires and avoiding the combustion of vegetation contributes to more intense fires in future as the vegetation builds up and the forest ages. This is known as a fire deficit (Parisien et al 2020). As Haines Junction and the surrounding area has a limited occurrence of lightning due to the influence of the St. Elias Range, it therefore has had limited naturally caused ignitions relative to most other Yukon communities. From 1958 to 2018, there were 52 fire starts within the municipal boundary of Haines Junction that burned a total of 9 acres. However, all but one of these fires were human caused. Within the area, but outside of the municipal boundary, there have been some fires worth noting. The 1997 fire at Bear Creek, 8 kilometres of Haines Junction, burned an area of 3,298 hectares quite intensely, but under mild weather conditions (Beaver 1997). In the spring of 2019, another fire in Bear Creek burned 604 hectares under warm, dry, gusty conditions. Refer to Figure 10 for an overview of the fire history close to and in Haines Junction.

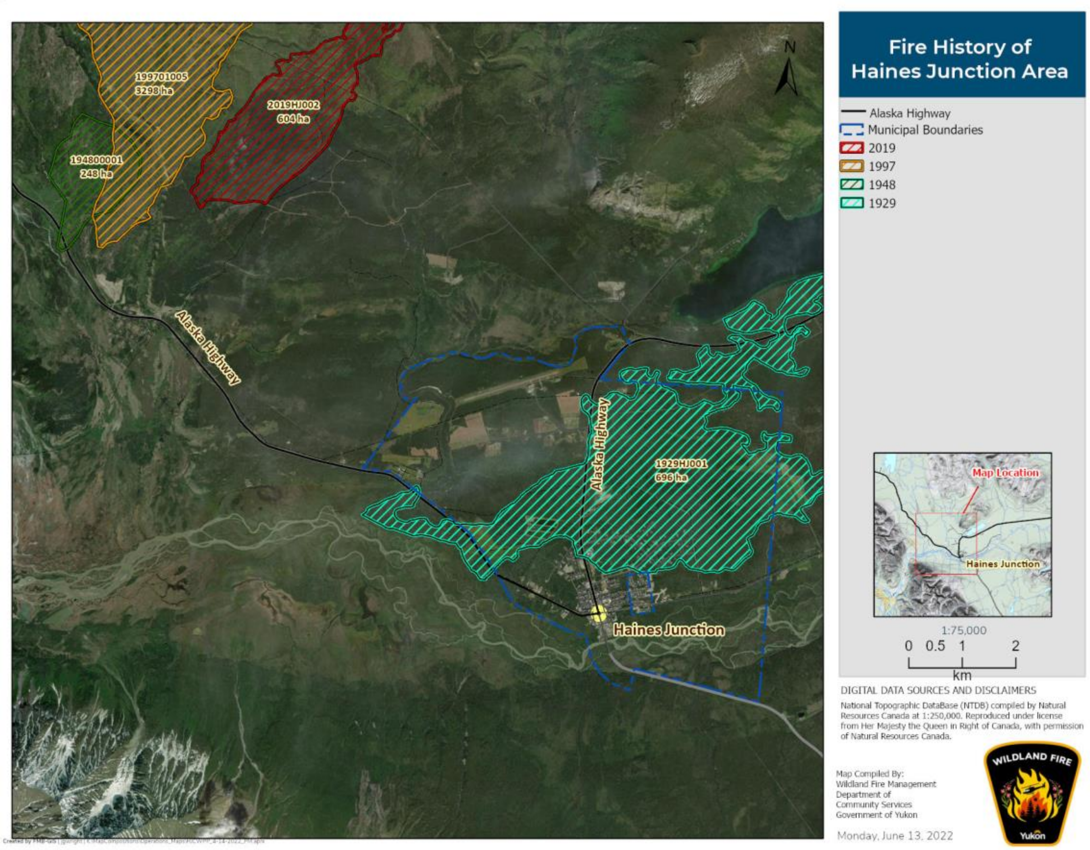

Figure 10. Fire History of Haines Junction and area.

Forest Age

The age of a forest has an influence on its potential flammability. Forests less than 30 years old contain more moisture and are less flammable. 'Mature' or 'overmature' forests not only have more dead and dry trees and limbs, but there is more likely to be a greater volume of what is known as 'coarse woody debris' on the forest floor. Younger forests can also act as a buffer between more flammable (ie. Older) forest and an approaching fire (Parisien et al 2020). The 2016 Fort McMurray fire is an example of just how vulnerable older forests can be. Heavy fire suppression had been practised there for more than 50 years.

Climate Change

Observed and predicted changes in the climate can be considered a hazard contributing to fire risk. Characterizing all the influences and dynamics of climate change on fire risk is complex. However, it has been reported for the last 20 years or more that climate change is expected to result in fires that are more intense and frequent, with an extended fire season. All of this will contribute to more rapid fire spread due to extreme weather (Wang et al 2015). Forests are anticipated to be more subject to pest and disease outbreaks, further contributing to fuel availability and ignitability for fires. For wildland fires to occur, there are three key elements that coincide: fuels, weather and ignitions (Parisien et al 2020). The trend towards more frequent and intense fires in Canada is partly attributed to increases in weather conditions that support extreme fire behaviour. A number of studies and reports indicate this trend will continue under the projected scenarios for climate change (IPCC 2022). The duration of the fire season is also starting earlier and finishing later than it did historically.

The changing climate in the Arctic and sub-Arctic (southwest Yukon is classified as sub-Arctic) regions is anticipated to take place twice as fast as other latitudes and environments. Between 1951 and 1980, the annual average Arctic temperature rose 1.2°C and may rise as much as 2.3°C from 2070 to 2100, modelled under a high emissions scenario[4]. In KNPR, even more significant temperature increases have been recorded, with an annual temperature of ~4.2°C from 1945 to 2016. This general trend of warming temperatures is a driving factor for the 1994 to 2008 spruce bark beetle outbreak and for other health impacts in the area. Due to warmer winter temperatures, beetle larvae survive more than they used to. Cold winter temperatures would help keep the beetle populations in check. It is also

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4www.climatedata.ca

reported that the dieback serpentine leafminer observed in trembling aspen can be attributed to warmer conditions (FMB 2019).

In summary, there are multiple impacts on ignition risks resulting from a changing climate. Fire suppression is expected to be challenged under the anticipated changes in climate (Parisien et al 2020).

Windthrow

Also known as blowdown, windthrow is the term for trees that have been blown over as the result of a wind event. The cause is usually attributed to 'butt rot,' or rotting at the base and subsequent weakening of the base of a tree. A lack of windfirmness is another cause of windthrow. If a tree that relied on its neighbour as a buffer for strong winds has neighbouring trees removed, its root structure is unable to support itself under the force of strong winds until it becomes 'wind firm.' Windthrow can result as a combination of butt rot and a lack of windfirmness. Field observations in beetle-affected stands adjacent to Kluane Lake show that thawing permafrost is also contributing to windthrow. Examples of windthrow of beetle-killed white spruce in Alaska range from 16 to 50 years following an outbreak (Hawkes et al 2014). Soil moisture and wind dynamics influence the ability of beetle-killed trees to remain standing. Windthrow causes trees to either fall to the ground or get hung up in surrounding trees, particularly in denser stands and trees with higher mortality. Heavily affected areas will have what is referred to as a 'laddering of fuels' effect, as blown over trees lean over each other and on standing trees. Windthrow from spruce bark beetle-killed trees has been observed in the Haines Junction area and the wider beetle-affected Kluane region for approximately 20 years, with a marked increase in recent years as the beetle-killed white spruce has reached a stage in its decay such that it is toppling over.

Figures 11 and 12. Examples of beetle-killed white spruce windthrow in the area. Figure 11 illustrates windthrow following firewood harvest.

From a fuel hazard perspective, this situation presents an elevated fire risk as the laddering effect of windthrown trees can cause a surface fire to more easily transition to a crown fire. This is a common issue in the white spruce forest around Haines Junction and is a major contributing factor to fuel hazards in southwest Yukon. Tree mortality caused by the spruce bark beetle outbreak has resulted in a high volume of beetle-killed trees that are more than 20 years old. This factor, in addition to local white spruce forest having shallow rooted trees, influences the hazard for the area.

Ignition Risks

Climatic Influence

The incidence of wildfires is set to increase concurrent with a trend in drier conditions and high temperatures. Indeed, three of the biggest fire years occurred within the last five years (2017, 2018, 2021). Work by Jain et al (2020) analyzed trends in observed global extreme fire weather and their meteorological drivers from 1979 to 2020. This determined that the relationship between atmospheric humidity and high temperatures is contributing to more wildfires.

The polar jet stream occurs at an altitude of 10 kilometres and, at 40 to 60 degrees latitude, separates cold arctic air from sub-tropical. Its influence on extreme wildfire activity is an active area of research[5]. The dynamics of the jet stream are now thought to be a potential predictor of extreme fire incidence and intensity (Jain and Flannigan 2021). Events such as the Fort McMurray Fire (2016 Horse River Fire) are linked to the formation of an upper-level atmospheric ridge (Petoukhov et al 2018 in Jain and Flannigan 2021). Spatial and temporal information on the polar jet stream could therefore contribute to an early forecasting system for extreme fires.

Precipitation

Overall, Haines Junction has a dry climate. The area experiences short summers and long, cold winters. Southwest Yukon experiences low precipitation due to the strong rain shadow effect of the St. Elias Range in spite of the relatively close proximity to the Pacific Ocean (150kms), particularly in summer months. The annual average precipitation for Haines Junction from the 1950s to 1982 was 292.5 millimetres (Francis 1996). A compilation of climate data trends by Parks Canada (2018) in KNPR show that annual precipitation has had a 100% increase from 1945 to 2006. This includes a rainfall increase of 86% in that period.

Along with the rest of the Yukon, there has been an increase in record snowfall in Haines Junction in recent years[6]. From a fire risk perspective, a heavy snowpack can leave the impression that a wetter spring will increase surface (duff layer) moisture. While this is true, it is the timing of snow melt that plays a bigger role in moisture levels rather than the volume of snowfall[7]. Higher levels of rainfall will contribute to more vegetation growth, which can increase the volume of fuel available for future fire seasons.

Temperature

The mean annual temperature is approximately -3°C and the mean temperature is 11 °C in June and -21°C in January. In the adjacent KNPR, an increase in annual temperature of ~4.2°C from 1945 to 2016 was observed. Average winter temperatures in the same period increased by ~6.3°C (Parks Canada 2018).

Wind

5 Piyush Jain, Research Scientist, Canadian Forest Service, Natural Resources Canada, Personal Communication.
6 https://www.cbc.ca/news/canada/north/whitehorse-records-snowiest-december-since-1980-says-environment-canada-1.6300135
7 Uma Bhatt, Professor, Atmospheric Science, University of Alaska. Personal Communication.

The prevailing wind for Haines Junction is southwesterly and averages approximately 8 kilometres per hour during the fire season of May to September. Brief but intense windstorms can be generated from the Kluane Icefields to the southwest of Haines Junction. The region is also known for high wind events, up to 90 kilometres an hour, particularly in spring and early summer. Wind from the southeast occurs on a less frequent basis, though is accompanied by more intensity, warmth and humidity due to coastal influence.

High altitude winds above 10,000 or 15,000 feet, also referred to as the steering flow, follow different patterns than surface winds. These winds, however, can have a strong influence on the atmospheric dynamics that contribute to lightning events.

Lightning

Historically, Haines Junction and the Shakwak Trench have been in a lightning shadow due to the close proximity of the St. Elias Range. A study of fire history in Kluane National Park and Reserve determined that there were no lightning-caused fires between 1963 and 1981 (Hawkes 1983). This data corresponds with observations of no lightning-caused fires within KNPR 2001 to 2021[8]. The exception to this was a fire ignited by lightning August 6, 2021 on the northeast side of Kathleen Lake. The other known lightning-caused fire in the area in recent history was a fire at Bear Creek in 1997, 8 kilometres northwest of Haines Junction (Beaver 1997).

In the last few years, however, there has been an observed and recorded increase in the number of lightning events in the Haines Junction area[9]. This trend is consistent with observations made by Environment Canada through the National Lightning Detection Network[10] of an increase in lightning in Canada's north and west (Aftergood, O. 2021; Kochtubajda and Burrows 2020), and what has been observed in Alaska (Yang et al 2021). In 2019, the National Weather Service in Alaska recorded, for the first time, lightning strikes within 500 kilometres of the North Pole. Research at the University of California published the results that describe the anticipated increase of Arctic (and boreal) lightning strikes will be approximately 100 percent higher by the end of the century (Yang et al 2021).

The summer of 2004 was a season of fires in the Yukon: 282 fires burned an area of 1.7 million hectares. Extreme fire behaviour in 2004 correlated with a persistent high-pressure

8 Scott Stewart, Fire and Coordinator, Kluane National Park and Reserve, Parks Canada, Personal Communication.
9 Scott Stewart, Fire and Coordinator, Kluane National Park and Reserve, Parks Canada, Personal Communication.
10 Gabor Fricska, Service Liaison Meterologist, Environment Canada, Personal Communication.

system that resulted in higher-than-average temperatures (by 2.5°C) and lower-than-average rainfall (by 20%). It was also a year of an unusually high number of lightning strikes. Records were broken of the total area burned in the Yukon and Alaska in 2004, as well as the number of cloud-to-ground strikes and the number of lightning-caused fires. A relationship between the higher incidence of lightning and of fires was examined by Kochtubajda et al (2011).

> *'The unusually warm summer of 2004 and exceptional lightning experienced in Yukon may provide a hint of the future.' Kochtubajda et al 2011*

Persisting high-pressure systems that remain stationary for an extended period is also known as an Omega. It can result in higher-than-average warming and drying in some areas, and an increase in rainfall in others. Lightning strikes were noticeably more frequent around Haines Junction in August of 2021. The August 2021 lightning-caused fire corresponds to records of an increase in lightning activity at that time. Environment Canada records show, for example, that on August 2 and 3, 2021, there were a reported 3,800 lightning strikes in a 24-hour period in the region. Refer to Figure 13 for a view of cloud-to-ground strikes in and around Haines Junction during that same period.

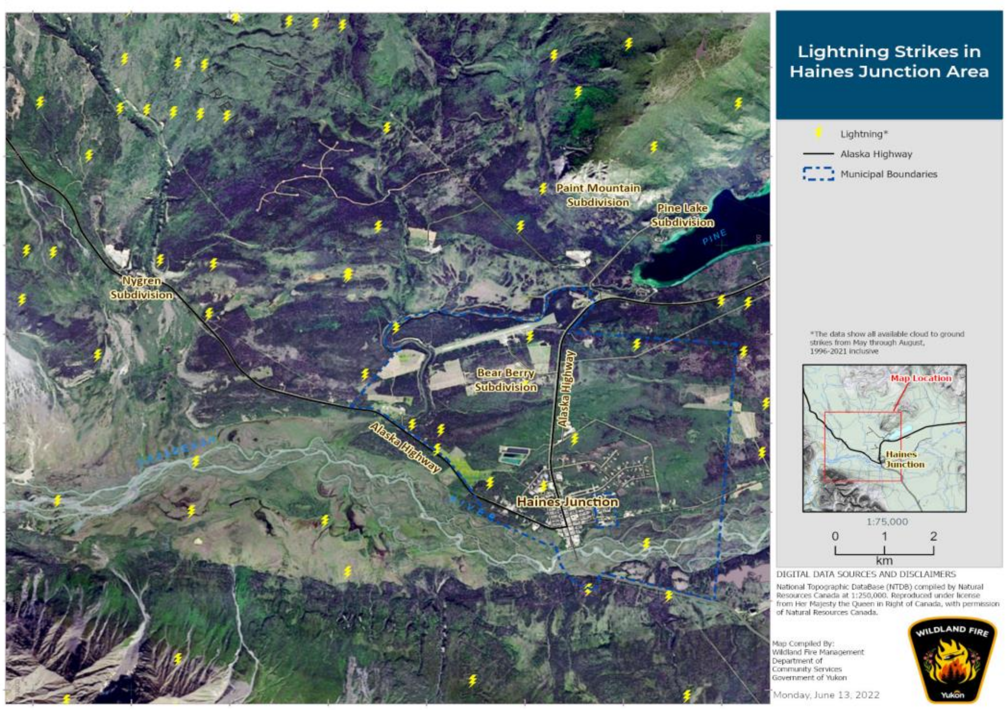
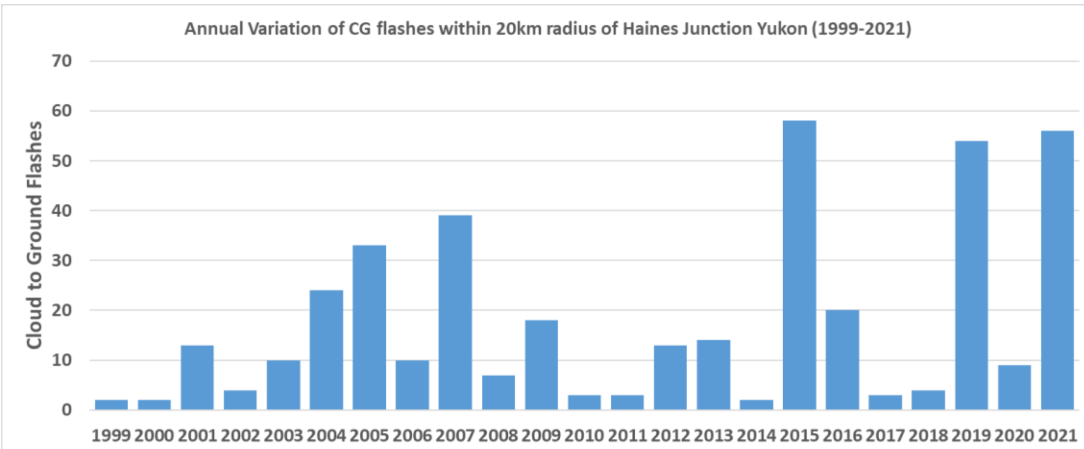


Figure 13. Cloud-to-ground lightning strikes 1996 to 2021 around Haines Junction.

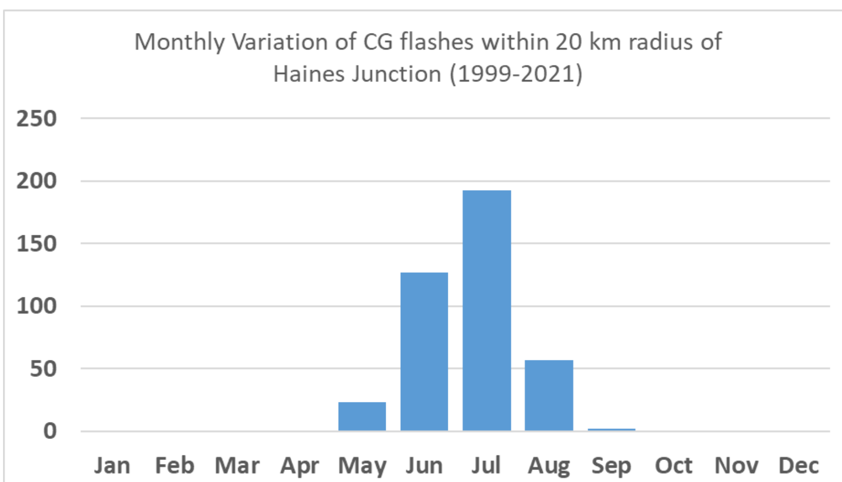
A review of data collected by the Canadian Lightning Detection Network over the last 23 years shows that the last 7 years have seen a 110% increase in the average number of cloud-to-ground lightning strikes[11], displayed in Table 1 below.

Table 1. Lightning strikes around Haines Junction (1999 to 2021).



The incidence of lightning during the summer season is shown in Table 2 below.

Table 2. Occurrence of lightning strikes annually around Haines Junction



11 The number of lightning events has increased by 53%, but the number of cloud-to-ground strikes has increased by 110%. The difference can be explained by multiplicity. That is, a single lightning flash may have multiple cloud-ground lightning strikes associated with it. That is, a flash can fork into multiple branches and each branch that touches the ground is counted as a lightning strike. Lightning sensor technologies have also improved (by approximately 10%), which could account for some of the increase in strikes recorded.

A cloud-ground strike does not of course usually result in ignition. Factors influencing ignition potential include whether a strike is positively charged, as well as the current (power) within the strike. Factors on the ground, such as surface moisture, available fuels and wind speed will also determine ignition. The beetle-affected spruce forest around Haines Junction has a high proportion of dead trees, a readily combustible fuel, which elevates the likelihood of a strike to result in ignition.

Strikes that are not accompanied by rain, typically in the early and late stages of a thunderstorm, are more likely to be positively charged and result in ignitions. Based on what has been observed in the Yukon, the late stages of a thunderstorm are especially important for the potential for ignitions (Kochtubajda et al 2011).

Lastly, the incidence of fall (autumn) lightning that caused ignitions that overwinter underground has been observed, including in Siberia. A similar process was observed in Haines Junction in 2019. A fire used to burn a brush pile of logging debris during the winter of 2018/19 continued slowly burning underground and resurfaced in May 2019 under warm, gusty conditions. An above ground fire developed as a result. It burned 604 hectares approximately 8 kilometres northwest of Haines Junction.

In summary, the frequency of storms that generate lightning will be a strong influencing factor on the frequency and spatial pattern of fire on the landscape.

Human-Caused Ignitions

People are typically the single largest cause of fire ignitions. This is certainly the case for Haines Junction and the surrounding area. A total of 52 fires were started and extinguished within the boundary of Haines Junction over the last 60 years. Of these fires, 100% were caused by people. All fires were extinguished relatively quickly and burned a small area.

Common sources of human-caused ignitions are unattended campfires, cigarette butts and burning brush and debris. The list of potential fire-causing activities expands on extreme fire danger days. Activities such as chainsaw operation, the use of heavy equipment and welding can all cause sparks, which can contribute to ignition potential. As described above, large burn piles in winter have the ability to go underground and flare up the following season. However, campfires pose the largest risk Yukon-wide and around Haines Junction.

Campfire locations in and around Haines Junction, in both official park campground and popular unofficial campfire locations, are checked closely and routinely by local fire personnel during the fire season to ensure they are extinguished. Approximately one fire per week is identified as not fully extinguished and could be a potential source of ignition. Monitoring of campfire pits in Kluane National Park and Reserve, particularly daily monitoring of the Kathleen Lake Campground, report the same high incidence of unextinguished fires[12].

Other Ignition Sources

Power lines contribute a significant risk to ignitions, particularly when dead trees adjacent to a power line fall on the line. A fire in Marshall Creek, east of Haines Junction, was started in 1999 due to trees that blew onto the power line (YG 2008). Line right-of-ways and power lines require continual maintenance to keep vegetation clear of power lines and reduce the incidence of fire.

Forest Health and Fire Risk

Forest health plays an important role in forest and fire management. They are integrally linked. There are two main risks to forest health, including pests and diseases. Increasingly, however, other forest health factors have gained attention, such as drought and, relatedly, climate change. Fire risk can be strongly influenced by forest health. Consequently, a discussion of fire and fuel hazards should consider the linkages to forest health. While fire is a naturally occurring feature of the boreal forest, fire behaviour that is more intense and more complex to manage, and which is uncharacteristic of historic fire behaviour, has greater impacts on forest health and ecosystem function. This section will discuss the relationship between forest health, fire and a major pest outbreak in the area, the spruce bark beetle.

Spruce Bark Beetle

Signs of a beetle epidemic were first seen in Kluane National Park and Reserve in 1994 (Hawkes et al 2014). The epidemic grew to cover an area of approximately 400,000 hectares. The outbreak was extensive within the Shakwak trench. It extended west to Kluane Lake and south to the Tatshenshini River Valley in British Columbia. The areas most affected were relatively close to Haines Junction, including the Alsek River drainage where it originated (Garbutt et al 2006). The outbreak affected 82% of the spruce forest in KNPR

12 Scott Stewart, Fire and Coordinator, Kluane National Park and Reserve, Parks Canada, Personal Communication.

(Wong 2017). Figure 5 (FMB map) shows the distribution of the beetle infestation around Haines Junction. Multiple factors contributed to the outbreak. A long-term drought impacted the ability of white spruce to adequately defend the bark beetle attack (Garbutt et al 2006). In addition, milder winters resulted in the beetle's ability to avoid winter die-off. Furthermore, the maturation of bark beetles was observed to occur in a one-year cycle instead of a two-year cycle (Werner 2006).

Measuring Fire Hazard Rating and Spot Fire Potential

A fire in 1997 that ignited 7.5 kilometres northwest of Haines Junction at Bear Creek, in beetle-affected forest, was subsequently used as a case study to examine fire intensity and observations of fire behaviour as a result of beetle-killed spruce (Beaver 1997). The fire ignited by lightning July 3, 1997 and burned under moderate conditions. Wind conditions were low and there had been above-average precipitation the previous two months. Regardless, the fire demonstrated high intensity and fire-spotting (up to 800 metres from the fire front), indicating the potential challenges for fire suppression of beetle-killed spruce (Beaver 1997).

Similarly, an Alaskan study of the impact of the spruce bark beetle on forest flammability reported that beetle-killed spruce is associated with more unpredictable and extreme fire behaviour (Alexander and Stam 2003). For example, candling, fire-spotting and crown fires were reported to be more common in spruce beetle-affected forest, even under what would seem to be moderate conditions. These observations point to greater considerations for fire suppression, particularly ground-based firefighting.

Dead trees typically ignite more easily than live trees due to a generally lower fuel moisture content. This can cause a higher-intensity burn than live trees. Under extreme fire conditions, fire intensity and convection activity are such that larger embers, and even cones and branches may be thrown ahead of the fire front[13].

The spruce bark beetle epidemic has made a substantial contribution to the fire hazard in the area by increasing the volume of surface and standing dead woody fuels loads (Garbutt et al 2006). A combination of factors contributes to potential for crown fires, including a dry climate and trees with relatively low crown heights. The highest volumes of surface fuels recorded in a CFS study that examined fire hazard rating in the area (Hawkes et al 2014) were near the mouth of the Alsek River, one of the areas affected early on by the spruce

13 Chris Stockdale, Fire Research Scientist, Canadian Forest Service, Personal Communication.

beetle outbreak. As mentioned, the Alsek Valley is also the source of the prevailing winds and the occasional strong winds that are directed towards Haines Junction. Garbutt et al (2006) state that if:

> “...*a lightning strike ignites the surface fuels in an area of moderate-to-high spruce beetle mortality, and the surface fire is intense enough to ignite the tree crowns, a wildfire of exceptional intensity is almost certain to follow.*”

Some beetle-affected forests in the Shakwak Trench have high spruce mortality (beetle-killed trees). The Alsek River Valley, for example, has tree mortality of up to 90% (Garbutt et al 2006).

The combined fuel hazards for Haines Junction is significant enough to warrant a review of the potential for wildfire in the surrounding boreal forest. An exposure rating measures this potential by examining fuel types along with the potential for torching, spotting and crown fires based on local vegetation data that is classified into flammability hazard ratings. This exercise was carried out in April 2022[14]. Refer to Appendix C for the hazard rating represented as ember spotting potential. Ember transport in the 0.1 to 100m range is shown in Figure 22. Ember transport in the 100 metre to 500 metre range is displayed in Figure 23. Note that the proposed fuel treatments are displayed along with the ember risk, also in Appendix C. Figures 24 and 25 show a strong correlation between the identified treatment areas for Phase 1 and the areas at most risk of ember attack at the 500 metre range.

Forest Health Monitoring

Efforts to observe and understand the impacts of the spruce bark beetle outbreak have been carried out by multiple agencies and researchers. Monitoring of the outbreak has been a valuable tool in understanding and managing for future outbreaks.

Parks Canada established a long-term forest monitoring program to identify if the structure and composition of spruce forests are anticipated to return to pre-outbreak conditions. From 2009 to 2010, 50 permanent sample plots were established. Plots were re-measured in

14 Based on the hazard rating tool developed by Jennifer Beverly, Jen Schmidt, Assistant Professor of Natural Resource Management and Policy at the University of Alaska, refined the tool-utilizing data derived from NASA's Landsat for 30 years (up to 2014).

2015. Monitoring of forest structure and composition included measurements of downed dead wood, fine fuels, tree regeneration and understory vegetation. According to the KNPR ecological integrity rating, the overall condition of the spruce forest structure was fair and stable, however, forest composition was determined to be good but declining (Parks Canada 2019). Kluane National Park and Reserve regularly collaborates with the Canadian Forest Service to conduct aerial forest health surveys of the park.

The Yukon Government actively monitors forest health through a Forest Health Monitoring Strategy that evaluates if management responses are required. The Yukon is divided into five forest health zones which are surveyed aerially every year on rotation. Haines Junction falls within Zone 2 and was surveyed by air in 2011/12, in 2016 and 2019.

The spruce bark beetle, northern spruce engraver, aspen serpentine leafminer and large aspen tortrix, and aspen decline are identified by the Yukon Government Forest Health Monitoring Strategy as the top four forest health risks for the region.

Values at Risk

Identifying values at risk and understanding the nature of the risk is critical in fire risk management planning. Most subdivision planning and development across Canada has not incorporated fire risk (AEM and Ember 2002). Major fires in recent years have highlighted this common issue. The 2016 fire in Fort McMurray, Alberta, for example, occurred in a community with a high proportion of structural values (residences) in close proximity to coniferous forest. The fire caused close to $10 billion worth in insured damages. Fire suppression costs were $500 million.

Virtually all values within the community of Haines Junction are at risk from wildfire. A number of physical structures could be impacted by fire in the community, in particular:

- Residences, commercial buildings and public buildings;
- Critical infrastructure, including the Haines Junction Health Centre (‘the nursing station’), the Haines Junction Aerodrome, communication and power lines, public roads, and the Alaska and Haines Highways.
- Sites of cultural and historic interest.

Less direct impacts that could be experienced include:

- Public health impacted by the reduction in air quality. This can have a range of health effects[15], particularly for those with asthma and other breathing disorders;
- Recreational values and viewscapes;
- Local industries, including tourism and the forestry sector;
- Wildlife and biodiversity values (through the loss of ecosystem function); impacts on fish and aquatic life through an increase in sedimentation of rivers and creeks.

Structural Features at Risk

The particular features that pose a risk to structures in the community are highlighted below. However, a more detailed overview of these features and recommended mitigation measures can be found in Section 4.

- Structures and areas that are within or adjacent to spruce forest or thick vegetation, particularly from spruce (or other conifer trees) within 3 metres. These structures and locations are most at risk from an ember shower, rather than ignition from direct contact with flames (conduction) or radiant heat.
- Structures built using flammable material, such as wood shake roofs and wood siding.
- Combustible material, such as firewood piles and construction material that are located near structures.

For more detailed information on reducing the risk to homes from ignition, refer to the Yukon Homeowner's FireSmart Manual.

Community Risk

Haines Junction

Much of the Village of Haines Junction has an aspen spruce mixed forest due to the regrowth from the 1929 fire. Aspen trees are the first to regenerate following a fire in a natural forest succession. The aspen spruce mix forest around Haines Junction is transitioning towards a spruce-dominated forest (see Figure 14 for an example).

15 https://www.ajc.com/life/health/exposure-to-forest-fires-linked-to-lower-birth-weights-study-says/J7PFJQTXNZGOBLBNJDYICXAIZ4/

While there are large areas of mixed stands, there is white spruce on all sides of the community that could generate an ember shower.

Figure 14. Mixed white spruce and aspen forest in Haines Junction, transitioning to white spruce-dominant forest.

Interface Risks

Potential features of a wildland interface fire, as distinct from urban fire events, include a range of additional considerations:

- Increased complexity and larger-scale incident;
- Multiple homes and structures may ignite within hours or minutes;
- A fire front is dynamic (not static);
- Limited access to water and other suppression resources;
- Potentially little time available to prepare and respond;
- Human life may be at risk;

- Safety concerns for fire response crews are elevated, particularly where there is not adequate defensible space;
- Losses of community values (ie. homes) are common.

It is worth noting the potential impacts of fire and smoke on travel corridors. Heavy smoke obscures visibility. The more intense and the closer a wildfire is, the thicker the smoke. This presents a threat to public safety, not only for those using travel corridors, such as fleeing on the highway in an emergency situation, but also for emergency service crews trying to gain access to an incident.

Risk Management

Risk Management Planning

While topography, weather and fuel all influence fire behaviour, only modifications to the fuels available to fire can be manipulated with intervention. For this reason, carrying out fuel treatments is a key objective of community wildfire protection planning. Fuel treatments can reduce the probability that a fire can transition from the forest floor into the canopy, reduce the fire intensity and reduce the rate of spread. A slow-moving, low-intensity surface fire is manageable, whereas high or extreme fire behaviour exhibited in crown fires can quickly exceed the capabilities of firefighters. It was reported that 90% of the structures lost in the Fort McMurray fire were attributed to ember transport that caused ignitions. Preventing crown fires and their spread is, therefore, a critical component to community protection. The Canadian Council of Forest Ministers (2016) note a "*serious and sustained increase in extreme wildland fire behaviour and wildland-urban interface events*" over the past 10 years. Extreme fires in B.C. and Alberta in recent years have highlighted this critical management concern.

There is a corresponding trend with the population growth and infrastructure development taking place in the wildland/urban interface. Haines Junction is no exception to this trend.

Risk Management in Haines Junction

The goal of fuel management is to reduce the potential fire hazard around the identified areas, focusing on the higher-risk areas first. These areas are identified from the fuel type maps pictured above, which are tied to prevailing winds that identify hazard areas to focus on.
The Haines Junction Forest Fuel Management group will be working together with the Yukon Government, Champagne and Aishihik First Nations Government, the Village of Haines Junction and community stakeholders to develop and implement fuel treatments for these areas. Public consultation will occur once a treatment has been prescribed for an area. Some of the treatments that are available to be utilized in fuel reduction are explained below.

> "*Extensive fuel management is the only option for mitigating potential losses.*"
> *Beaver 1997*

Collaborative Management and Capacity

As described, the planning contained in this document is the result of the Haines Junction Forest Fuels Management Working Group (input from WFM, Parks Canada, CAFN, ARRC and HJVFD). An earlier phase of planning was conducted in the development of the Haines Junction Community Fuel Abatement Plan (CFAP) from 2008.

The origins of the CFAP lie in the Strategic Forest Management Plan (SFMP) for the Champagne and Aishihik Traditional Territory (CATT), its Implementation Agreement and the Integrated Landscape Plan (ILP). This planning process identified community fire risk management as one of its highest priorities. The CFAP was designed to assist the community to reduce fire risk and to support wildfire preparedness. A multi-agency Fuel Abatement Technical Working Group (FATWG) developed fuel abatement priority zones for the ILP to assist in the development of fire hazard abatement plans and strategies. These zones are displayed in Figure 5 (FMB map) showing the Community, Interface and Landscape Zones. Treatment guidelines developed for this purpose were:

1. To reduce fuels at or near the forest floor to levels that reduce ground or surface fire potential and intensity;
2. To prevent ladders of fuel that the fire can climb to reach the crown level of the forest;
3. To reduce closely spaced coniferous treetops to an acceptable level, so crown fire potential is significantly reduced;
4. To encourage development of a vigorous forest that is less likely to be attacked by the spruce bark beetle;
5. To keep a forest structure and composition that will respect values for wildlife, ecosystem function, scenic beauty and cultural aspects as much as possible without giving up community safety.

Fire Detection

Monitoring of fire activity is a collective of various tools and technology. Over the last decade, a range of methods and technology are available that improve wildfire detection. Given the importance of early detection in fire suppression, awareness and investment in this component of community protection is key. Members of the public who alert WFM to smoke are a major contributor of fire detection. The area has had limited to no cell coverage until the last decade. Improvements in cell coverage advance the public's ability to call in fires. The

Haines Junction Fire Tower, while no longer staffed during the season, has fixed cameras that monitor fire activity. The remote camera at the Fire Tower ties in with the Hummingbird Network, a commercial fire detection service in the Yukon that uses crowdsourcing to detect visible smoke.

Remote satellites are also used to detect heat signatures. These are reported on a daily basis during the fire season.

Fire Suppression Capability

Wildland Fire Management

Haines Junction's capacity to respond to wildfire suppression is led by the Government of Yukon's Wildland Fire Management Branch. The Haines Junction Fire Centre is located within 5 kilometres of the community. The Fire Centre can host helicopters to support fire suppression operations.

Wildland Fire Management's mandate is to protect life, property and infrastructure from wildland fire while facilitating the creation of fire-resilient communities. In and around communities, this means complete fire control and suppression, whereas wilderness areas may be left to burn so that a fire can contribute to maintaining healthy and functioning boreal forest ecosystems. Wildland Fire Management adheres to a priority basis for responding to wildfires. The protection of human life and firefighter safety above all other priorities. The response to wildfires follows this priority basis of five wildland fire management zones:

- Critical Fire Management Zone (Red)
- Full Fire Management Zone (Orange)
- Strategic Fire Management Zone (Yellow)
- Transitional Fire Management Zone (Blue)
- Wilderness Fire Management Zone (Not coloured)

Refer to Figure 15 below for a display of the wildland fire management zones relevant to Haines Junction. During extreme fire conditions, the fire suppression action will be dedicated to the highest priorities, subject to available resources, prevailing fire environment conditions and the need to retain such resources for the overall protection of Yukon communities. Haines Junction falls within the Critical Fire Management Zone (Red) for initial attack and protection.

Firefighting crews are positioned across the territory early in the season. From mid-May to mid-August, a total of three crews are in place at the Haines Junction Fire Centre with three members in each crew. As with all fire situations across the Yukon, fire crew resources are deployed on an as-needed basis dependent on fire management priorities. Aircraft that can supply fire retardant are on standby in Whitehorse throughout the summer and can be deployed within 30 minutes as required. Water bombers can be made available within a 20 to 60-minute timeframe, dependent on other territorial priorities. These aircraft can operate out of the Haines Junction Aerodrome. In addition, Alaska water bombers may assist the Yukon when needed.

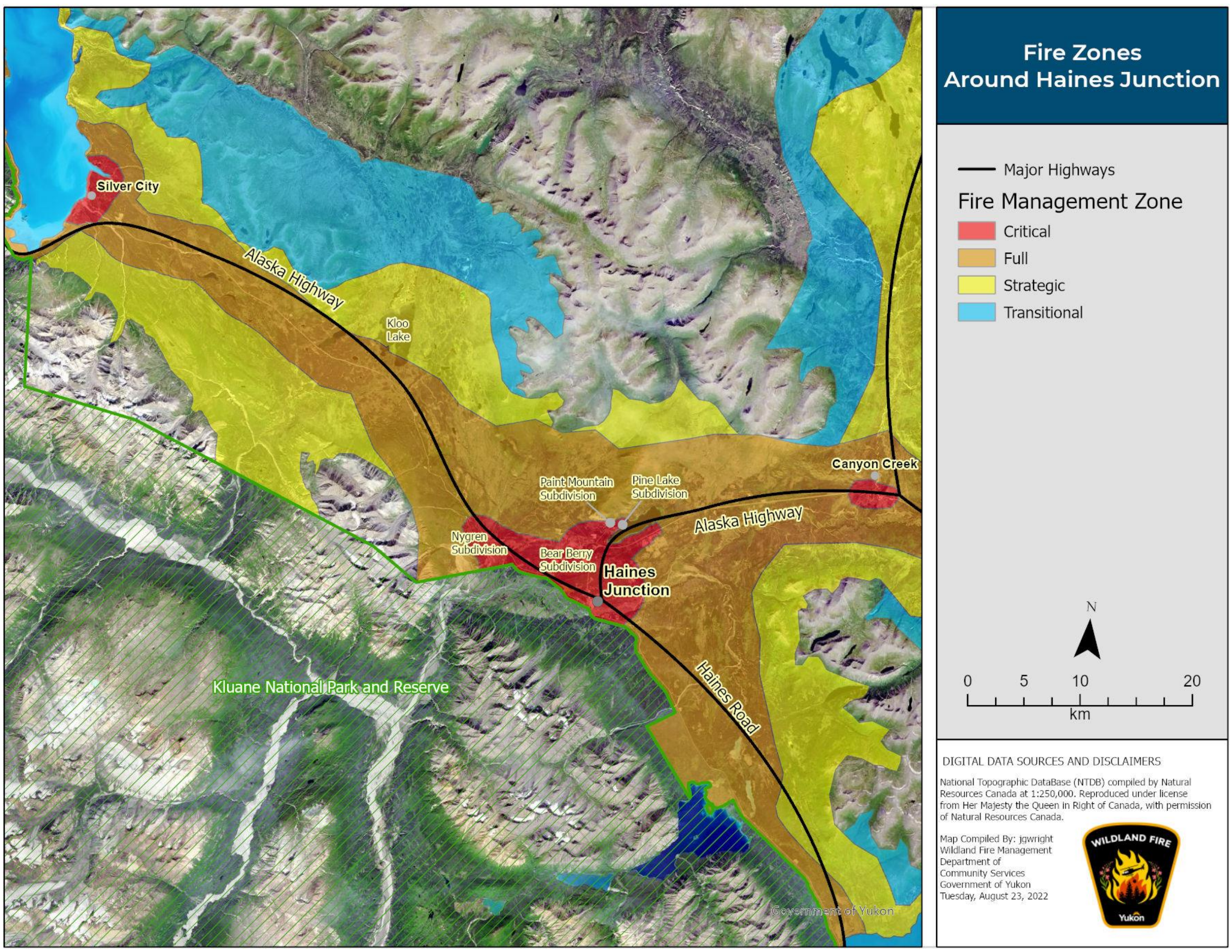


Figure 15. Wildland Fire Management Fire Zones

Kluane National Park and Reserve

Kluane National Park and Reserve maintains modest local response capacity to wildfire starts within the boundary of KNPR, supported by a larger national wildfire management program. During periods of anticipated high fire danger, Parks Canada may augment local fire crew capacity with national fire crews and other Incident Management Team resources from outside the territory. Aircraft may also be resourced for fire management purposes during these times of higher forest fire danger.

During the fire season, the Kluane Fire Coordinator and the Wildland Fire Management Regional Protection Manager for Haines Junction regularly communicate to review fire danger, preparedness levels and suppression resources. A central fire monitoring program uses remote sensing satellites to monitor heat signatures in Kluane National Park and Reserve.

In light of the increasing fire risk in and close to the community, including from within the park, there has been an added emphasis on collaboration between the two agencies. A formal arrangement regarding wildland fire management was signed in 2020 between Wildland Fire Management Branch and Parks Canada to recognize the mutual benefits of inter-agency collaboration in wildland fire management.

Village of Haines Junction

Within the municipal boundary of the Village of Haines Junction (VoHJ), the responsibility for responding to fire is that of the Haines Junction Volunteer Fire Department (HJVFD). The target focus of the HJVFD is to respond to structural fires, but the department will support Wildland Fire Management in fire suppression efforts as requested. The municipality of Haines Junction is home to a substantial forested area. Recognizing the capabilities and specialization of WFM in responding to wildland fire and interface fires, in the event of a fire in the forested area within the village boundary, WFM would play a key role in fire suppression.

The HJVFD is comprised of a Fire Chief, a Deputy Fire Chief, a dispatcher and firefighters. Currently the HJVFD has 14 members[16] (and is permitted to a maximum of 15). The

16 As of March 2022.

department has at its disposal three tanker trucks; two with a 1,000-gallon capacity and one with a 3,000-gallon capacity. All tankers are compatible with the +60 fire hydrants around Haines Junction.

Water and Access

Fire suppression water supply is readily available in a number of areas in the community, as well as interface areas through lake, creek, or river water sources. Pine Lake and Dezadeash River in particular, offer opportunities for water pumping. A hydrant system also exists in the community of Haines Junction as described.

A fire break (or 'fire guard') around the perimeter of the built-up area of Haines Junction serves as an access point for fire suppression. Like all community fire breaks, the one surrounding Haines Junction requires continual maintenance to ensure adequate widths and trail conditions. Restoration of the Haines Junction fire break would provide an asset to community wildfire protection. Refer to Figure 19 for the location.

Forest Resource Roads, used for commercial timber harvesting, can provide access for fire crews for suppression efforts. These roads are gated during their active years and then decommissioned (returned to a natural state) after commercial forest harvesting operations are complete and access is no longer required.

Fuel Treatments

Managing wildfires has focused on fire suppression as the main approach to fire response on the landscape. This was the dominant technique employed, particularly from the 1950s through to the 1990s. Recognizing that fire is an important component of boreal forest ecosystem function and renewal, and that a fire deficit can increase the fire risk in and around communities, other approaches to manage for fire have come to the fore of fire management in recent decades. Managing fuels can be explained as either reducing the quantity of fuel, converting fuel to less flammable types or isolating types (Beverly et al 2021). These treatments can be largely categorized as:

- **Fuel Reduction** involves selective thinning or clearing to reduce available forest fuels and create a more open stand structure. The overall goal is to reduce the fire intensity and rate of spread, as well as the probability of crown fire initiation and spread. Thinning is the most common method used for fuel reduction. FireSmart fuel management projects are a good example of this across the Yukon.

- **Fuel Conversion** involves replacing highly flammable vegetation with species that are less flammable. This is usually accomplished through first removing conifers (fuel reduction) and either planting deciduous species, such as aspen or birch, or promoting suckering of existing aspen already onsite. The ultimate objective is to increase the proportion of deciduous species relative to the proportion of coniferous species within a forest stand.
- **Fuel Fragmentation** involves breaking up blocks of continuous coniferous (spruce) forest with the goal of reducing the intensity of a fire and the rate of spread in order to reduce the advancement of a crown fire.
- **Prescribed Fire** is intentionally lit fire that burns under specific conditions to reduce fuel loads in a specific area. Prescribed burning is an effective tool and often used following a fuel reduction and fuel fragmentation treatment. Can be effective in combinations.

Some of these treatments can be implemented to complement each other's fire risk reduction. Effective fuel management provides defensible space for responders to more safely and successfully fight fires threatening the community. Fires in treated forest stands are typically detected earlier. The increased visibility enables firefighters to locate and access a fire. Additionally, suppression by helicopter and airtankers is more effective in an open stand structure where water and fire retardant are better able to penetrate the forest canopy and reach fuels on the forest floor. The following section elaborates on which of these treatments are most relevant to the community of Haines Junction.

Fuel Reduction

Thinning

Thinning is a precise method for modifying stand structure through either hand falling/cutting or mechanical cutting. Thinning focuses on removing specific species of tree, such as spruce, or specific age classes of trees. It also includes pruning limbs to reduce ladder fuels. Taken together, these measures aim to reduce the volatility of a forest stand as well as the probability that a surface fire can move into the forest canopy.

Thinning has largely been adopted in the Yukon on community FireSmart fuel management projects. A two-stage thinning treatment can be used to reduce the risk of windthrow (Beverly et al 2021). This involves an initial removal of 1/2 to 2/3 of the biomass, followed by the remainder 5 to 10 years later.

The FireSmart Funding Program has supported a number of treated areas in Haines Junction. Refer to Figure 16 for an overview of areas thinned under the FireSmart Funding Program.

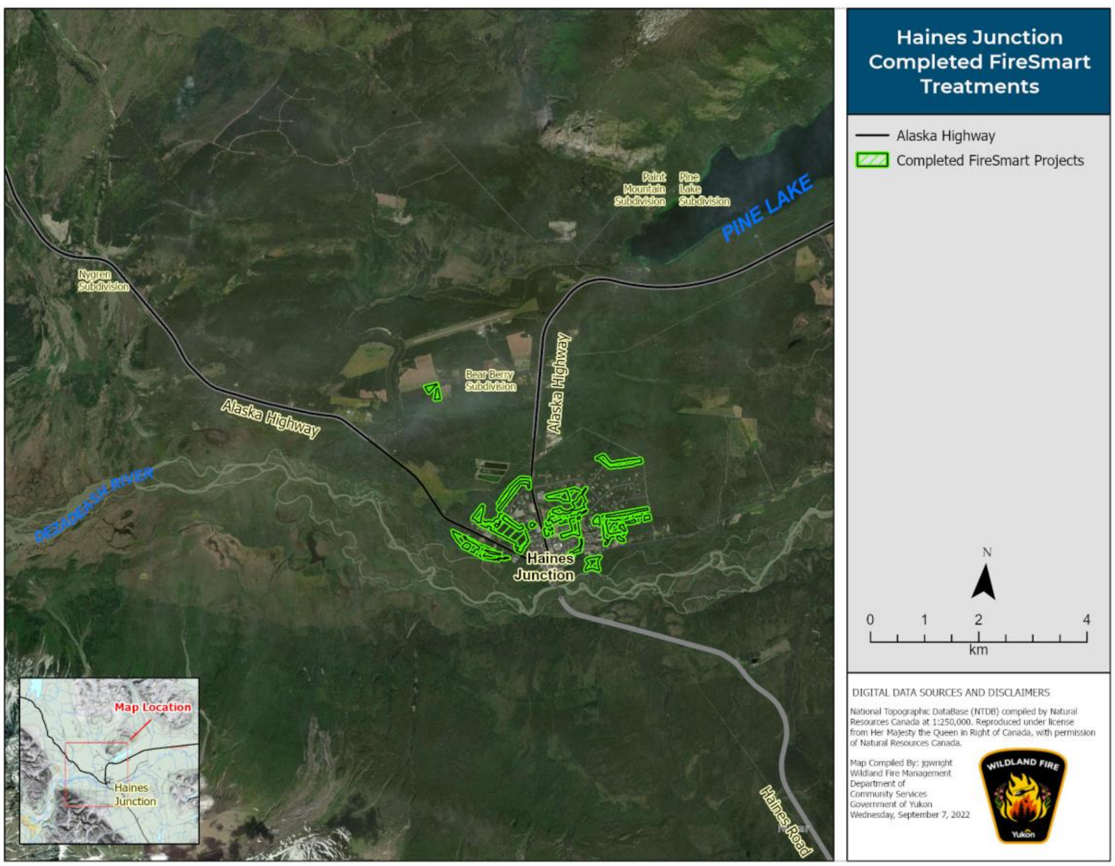


Figure 16. Areas treated under the FireSmart Funding Program around Haines Junction.

Fuel Conversion

Fuel or stand conversion is essentially the replacement of one tree species for another. A less flammable species like trembling aspen would reduce fire risk compared to that of a conifer (spruce) forest. A conversion would also alter the age class of the forest. Younger forests are less flammable than mature ones. In 2015, a small area of white spruce south of Haines Junction was intentionally converted to aspen by planting for the purposes of fuel conversion (see Figure 5 for a location of the site).

Fuel Fragmentation

Fire Breaks

These are linear strips where all vegetation has been removed down to mineral soil, leaving a non-combustible section of ground. Fire breaks are typically not wide enough to stop embers from crossing, but will stop surface fire and will provide fire suppression forces a higher chance of successfully attacking a fire. Fire breaks provide a defensible location to slow down or even change the course of some less intense fires. Purpose-built fire breaks on the perimeter of communities or neighbourhoods can serve as access for fire crews. They can also serve as safe areas from which to conduct fire management operations, such as setting up sprinklers or burning fuels between the fire break and a wildfire (also known as backburning). For older, highly flammable forests, establishing fire breaks is a critical tool (Parisien et al 2020). Networks of fire breaks help to break up the landscape into smaller and more manageable sections (Skinner). In the picture below a firebreak serves as a line from which fire management personnel conducted a successful ignition operation to burn out fuels between the break and the Bear Creek fire in 2019.

Figure 17. Fire break limiting spread of 2019 fire

The effectiveness of fire breaks can be increased if adjacent to a prescribed fire treatment.

Although there is no standard for width of a fire break, effective fire breaks have been recorded at 65 metres to 90 metres (Skinner). The 30 metre-wide fire break adjacent to the town of Waterton in Waterton National Park was used as an effective tool that played a critical role in sparing the townsite from destruction during the 2017 Kenow fire. The Haines Junction fire break ranges from approximately 8 metres to 20 metres wide. The ability of a fire break to provide access for fuel suppression efforts is also dependent on the safety of a fire break. For example, if a fire break is narrow or unmaintained, they are less likely to be entered than wider and well-maintained ones (Skinner). The utility of many past fire breaks has been significantly reduced because of a lack of maintenance, as woody vegetation encroaches over time and fuel loads increase.

A map of the fire break around Haines Junction Is shown in Figure 19. A significant fire break was constructed around the Nygren subdivision to address the elevated fire risk in that area.

Prescribed Burning

Also known as controlled burning, a prescribed burn is intentionally lit under certain conditions on low fire risk danger days in areas targeted for fuel reduction. The treatment results in less available fuel in the event of a wildfire, thus making a fire more manageable. By burning small areas frequently rather than a single large burn, fire risk reduction can be achieved more safely (Parisien et al 2020).

Timing and location are factors that limit the parameters of a prescribed fire. The parameters for conducting a burn are quite specific, but, as there is a risk for a fire to escape its edges, cool shoulder season conditions are targeted. Wildland Fire Management has a rigorous process in place for prescribed fire. Careful planning that targets specific weather conditions is used to achieve the desired reduction in fuels. These plans vary in complexity depending on the targeted fuels, nearby values at risk, prescription and other factors. A communications plan is available for area residents and interested parties wherever a prescribed fire is planned.

Other Treatments

Chipping

Trees and shrubs that are cut and chipped to reduce fire hazard can be spread onsite as mulch. This is a common practice. Alternatively, the chipped material can be hauled away and used as fuel for biomass heat or it can be composted. Chipped material (mulch) left onsite can, under some circumstances, also present a fuel hazard. Compacting mulch to increase soil-to-chip contact increases fuel moisture content and reduces the fuel hazard.

Timber Harvesting

By targeting areas for timber harvesting, which is typically firewood in the Haines Junction area, that coincide with higher fuel loads and beetle-killed spruce, forest management can serve to reduce the fuel hazard in the area by removing fuels. Strategic selection of harvest blocks towards this end have been incorporated into timber harvest planning as represented in the Integrated Landscape Plan and Haines Junction Community Fuel Abatement Plan (2008). Refer to Figure 5 for a map of proposed timber harvest blocks for this purpose. The Quill Creek Timber Harvest Plan, the McIntosh East and the Pine Canyon Timber Harvest Plans all align with the goal of fuel reduction and fire risk reduction. It is worth nothing that there exists the potential for fuel loading to increase in harvested cut blocks if debris (ie. tops and limbs) are not adequately dealt with, or, in the case of Haines Junction, if windthrow significantly increases the volume of downed and laddered coarse woody debris. Fuel abatement blocks will take into consideration canopy fuels, surface fuels, and coarse woody debris.

Fuel Treatments for Haines Junction

Haines Junction

Although much of the public land in the community has undergone fuel treatment, there remains more work to do. Enhancing existing fuel treatments and addressing fuels on privately owned lands will continue to be ongoing planning priorities.

Treatment

1. Maintain naturally occurring deciduous fuel type adjacent to/surrounding community.
    a. Removal of emergent conifer understory in aspen-dominated forest stands.
    b. Plant aspen in fuel treated areas.

2. Upgrade the original firebreak around Haines Junction.
3. Continue FireSmart fuel management activities within Village of Haines Junction municipal boundaries.

Figure 18. FireSmart Thinning treatment within Haines Junction

Nygren Subdivision

This area north of Haines Junction contains tracts of open grassland upwind, but sufficient conifers within range of the subdivision to cast ember showers against structures. Much FireSmart fuel management work has already been done by individual homeowners. A 200-metre wide fire break was created in 1997 around the south and west sides of the subdivision, which is currently regenerating into an open spaced mixed wood aspen/spruce stand.

Treatment

1. Support FireSmart fuel treatments on privately owned land within the subdivision.
2. Maintenance of fire break surrounding the subdivision.

Bear Berry Subdivision

This subdivision is situated within a conifer stand and requires extensive FireSmart work on privately owned properties to mitigate hazard.

Treatment

1. Isolate or fragment concentrations of coniferous fuels adjacent to and within subdivision.

Pine Lake and Paint Mountain Subdivisions

These subdivisions have a large mixed wood component surrounding them, but with sufficient conifer component to cast embers if fire intensities are high. They are also located in the path of extensive spruce forest and prevailing winds.

Treatment

1. Manage emergent conifer understory in forest fuels adjacent to subdivisions.

Priority Areas for Targeted Treatment

The following areas are identified for treatments over the coming years of CWPP implementation. Treatments may not be limited to these areas, but these will be a focus of planned treatments. A number of fuel treatments may be applied for these areas, including fuel reduction (thinning and fuel removal (for example, clearing), fuel conversion and fuel fragmentation. Figure 19 below identifies areas selected for priority treatments.

Phase 1 – Highlighted in red, these are areas that are identified for immediate and priority treatments to reduce fire risk for the community.

Phase 2 – Displayed in orange, these are areas where a longer timescale is anticipated for implementing treatments. WFM would work with partnering agencies on the planning and implementation of these treatments.

Both phases incorporate CAFN Settlement Lands for treatment in and around the community. WFN would work with CAFN to support planning and implementation of treatments in these areas.

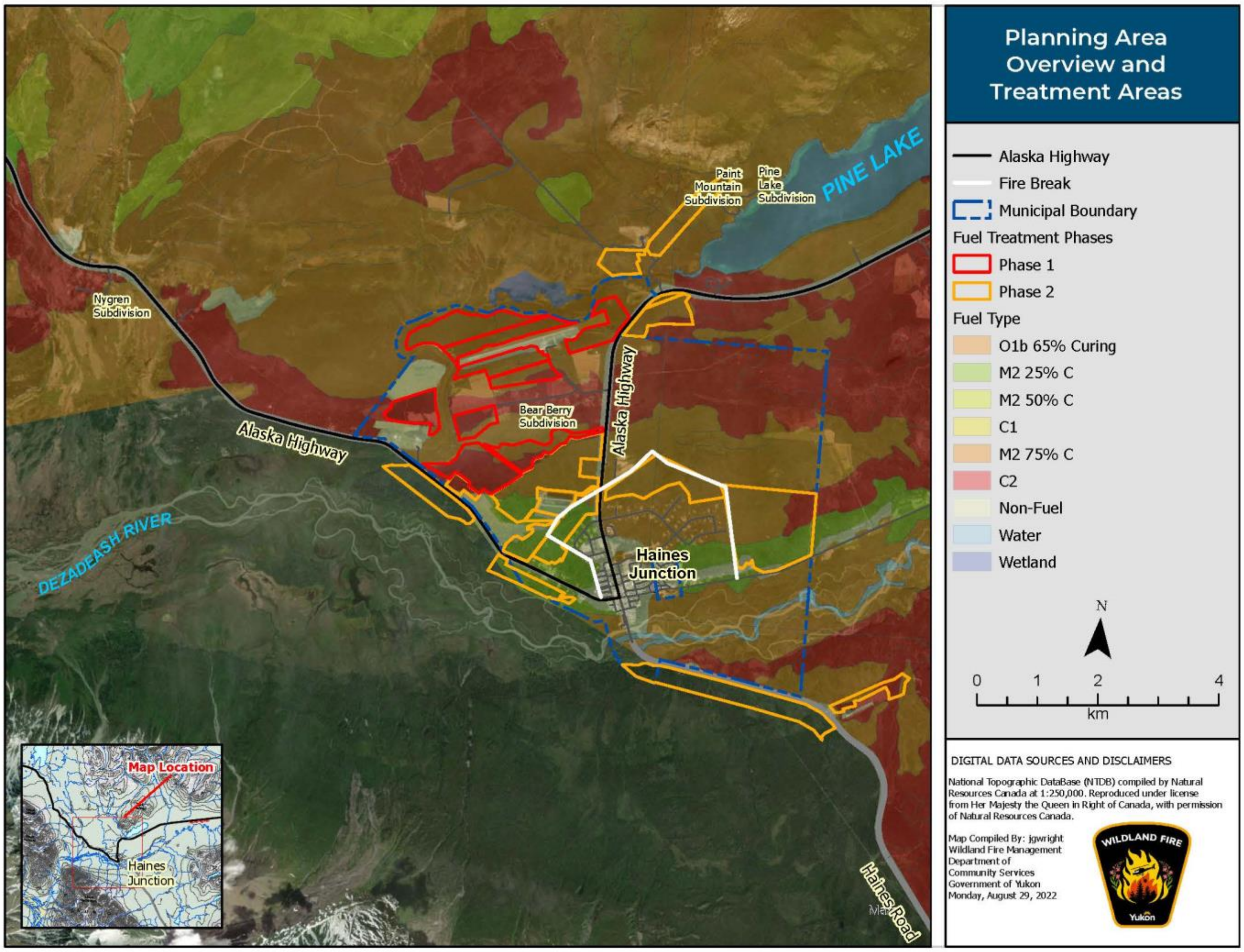


Figure 19. Haines Junction CWPP Area and Proposed Fuel Treatments

Structural Ignitability

The cause of ignition of a structure is typically from ember transport. Radiant heat or flame contact are not common sources of ignition, particularly when vegetation has been treated and sufficient clearance between homes and vegetation are in place.

The density of embers is highest within 100 metres of the fire front and can range from a dozen to several hundred embers per square metre. Embers may arrive several hours prior to the arrival of the fire front itself. Spot fires in boreal spruce forest attributed to embers are common 100 metres to 500 metres from the fire front, up to a recorded maximum of 9 kilometres. That is greater than the distance from the last two major fires in the Bear Creek area to Haines Junction (7.5 kilometres). It is worth noting that under severe fire conditions, the prevailing/typical wind direction may not be the source of wind that drives the direction of a fire front. Intense fires can generate their own winds that can cause unpredictable fire spread patterns.

Reducing structural losses from wildfire requires effective management of fuels near structures. Building design and construction materials are also factors that affect structural ignitability.

The Canadian Standards Association has produced a document entitled *Fire Resilient Planning for Northern Communities* (CSA S504:19). It presents a number of options and guidelines for building FireSmart communities and structures. Items to consider in the development of fire safe subdivisions include:

- Local vegetative cover, terrain, prevailing winds and rainfall amounts;
- Accessibility and volume of natural water bodies;
- Hard pipe water infrastructure and flow rates (how fast can water be pumped);
- Fire access and turnarounds for emergency vehicles;
- Structure density;
- Fire breaks constructed in key areas.

Wind-driven embers which land on combustible surfaces can quickly ignite if not suppressed. Some considerations for fire safe building construction:

- Class A fire-rated roof covering; the roof is the largest determining factor in whether a structure will be consumed by fire;
- Open attic and soffit ventilation can allow embers to enter attics or ignite soffits, fascia, rafters or attic spacers. By placing grills or screens over soffit and attic openings, fire risk can be significantly reduced;
- Choices for exterior cladding should be considered for their flammability;
- Attached decks and structures can allow fire brands direct access to the underside of buildings;
- Accumulated debris and materials storage can directly contribute to home ignitions;
- Decorative coniferous shrubbery and vegetation adjacent to any structure increases the likelihood of ignition.

The effectiveness of exterior fire suppression systems is surprisingly limited. Research suggests that in some instances the use of sprinklers is not ultimately effective in fire prevention. Simple garden hoses with roof-mounted sprinklers are most prevalent, but the total water volume delivered is relatively small compared to what is required. This is also susceptible to power outages. These systems are most effective in wetting and cooling specific building components, such as shingle roofs and ground fuels surrounding structures (ie. lawns).

Whereas the FireSmart guidelines are more centered on improving the resilience of *existing* communities, the National Research Council of Canada's 'National Guide for Wildland-Urban -Interface Fires' (Benichou et al 2021) is aimed at addressing a wider range of factors related to community development as it relates to the Wildland Urban Interface.
Haines Junction, like most communities, is located close to a wilderness interface area and there are opportunities for creating awareness for structural ignitability risks around homes and properties.

Reducing fire risk can be done by addressing fuel hazards, particularly within 30 metres of residences in consideration of the unavoidable scenario of ember attack under extreme conditions (Westhaver 2017). However, it is unrealistic to suggest that complete fire risk mitigation can be achieved for all wildfire scenarios. It is worth emphasizing that while fuel treatments are a critical component of fire risk management, under extreme fire weather conditions, fire suppression and fuel modification are tools with limited efficacy (AEM and Ember 2002).

FireSmart

FireSmart Canada is a national program of the Canadian Interagency Forest Fire Centre, which supports the reduction of wildfire risk and promotes fire safety and preparedness. FireSmart provides guidelines for proactive measures that can be taken by individuals and neighbourhoods in order to reduce fire risk.

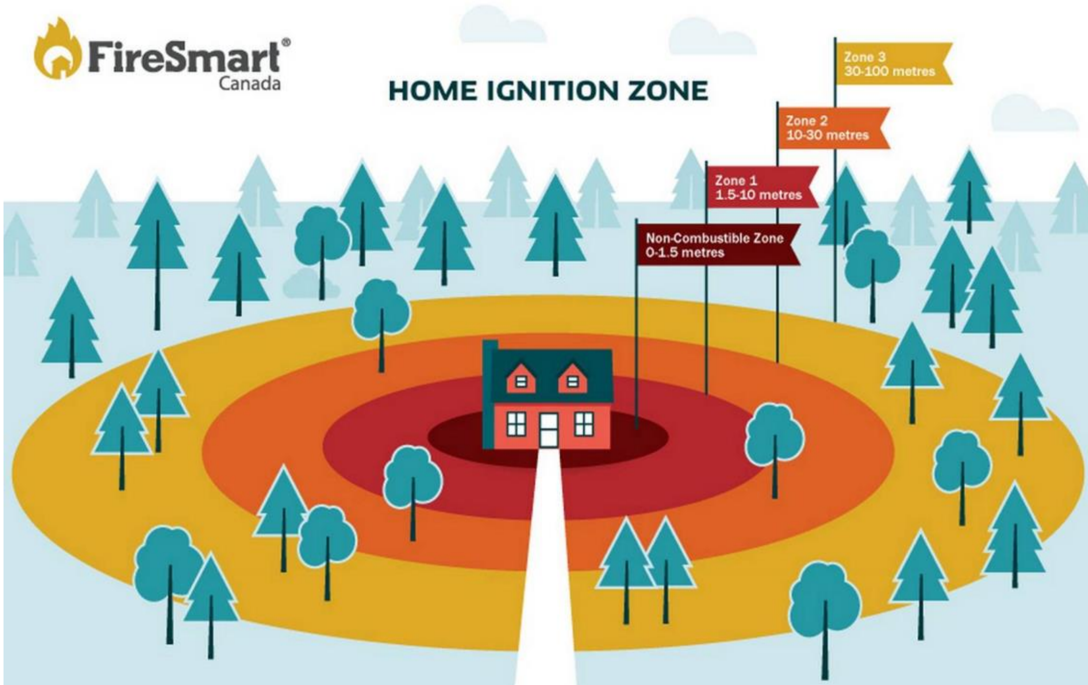


Figure 20. Home Ignition Zones, FireSmart Canada

Mitigating Community Risk

Becoming wildfire resilient is a shared responsibility for a community. Guidance for treatments to minimize community risk through fuel treatments and FireSmart activities are described above. The following is a list of actions to mitigate the risk of fire to Haines Junction that would largely fall to Wildland Fire Management to implement or initiate.

Reducing Ignition Potential

- Prevention signage at key locations.
- Maintenance and potential widening of the Haines Junction fire break.
- Ongoing FireSmart initiatives.
- Carry out fuel management on vacant lots before they are offered for sale to the public.
- Social media campaign promoting hazard and prevention messaging.
- Organize community brush clean-up days targeting dead and down woody debris.
- Work with power utilities to ensure power line right-of-ways are kept clear of snags and trees.

Steps Towards Community Fire Risk Reduction

- Follow and implement recommendations from the 2008 Haines Junction Community Fuel Abatement Plan.
- Promote new housing construction built to FireSmart standards, as per the national standards of Canada publication *Fire Resilient planning for Northern Communities*.
- Establish local FireSmart building codes or best practices for within community (Reference CSA *Fire resilient planning for northern communities*).
- Continue to implement FireSmart fuel management projects within and adjacent to municipal and First Nation lands.
- Promote fuel reduction and FireSmart activities on privately owned lands:
    a. Conduct free FireSmart assessments for property owners.
    b. Offer tax incentives to encourage FireSmart clearing by individuals on private property.
    c. Set up government rebates or loans for homeowners to carry out vegetation management on their properties or make FireSmart upgrades to their residences.

    d. Communicate to landowners the hazard of narrow driveways, including how this can limit or prevent access by emergency vehicles.
    e. Establish municipal bylaws to address fuel loading within the community.
- Improve emergency vehicle access routes within and around town.
- Install permanent sprinklers on the exteriors of critical infrastructure and government buildings.
- WFM participation in open houses and offering informational material during public meetings.
- In-person fire risk education awareness visits to the St. Elias School and the incorporation of FireSmart principles into the curriculum.

A recently acquired dataset from Forsite Consultants and Ember Research Services (B.C.-based forest data experts) using LiDAR technology will be an asset in fuel mitigation efforts. Using a pulsed laser, LiDAR is able to capture a three-dimensional representation of individual trees, which can be useful to examine fuel hazards near structures (100 metre radius) and identify which are most at risk. The dataset will also be able to review the state of forest fuels around the community, including to assess whether treatments such as Firesmarting have been effective.

Augment Fire Suppression Capacity

- Support the VHJFD: while their primary responsibility is structural fires, members have received wildland-urban interface training through the Fire Marshal's Office and have assisted with wildland fires when required.
- Strengthen the VHJFD fire protection Memorandum of Understanding with Wildland Fire Management.
- Practice scenarios and tabletop exercises among first responders to identify shortfalls, and establish clear lines of authority and communications.
- Continue collaboration with Kluane National Park and Reserve on fire suppression as per the formal Agreement.
- Expand the network of fire hydrants to newer subdivisions.
- Carry out training exercises with the VHJFD, Wildland Fire Management and Parks Canada.
- Provide Incident Command training for all appropriate staff within the Village of Haines Junction, Champagne and Aishihik First Nations Government and Parks Canada staff.
- Increase communications resilience such as cell tower reliability and battery back-up to ensure critical communication infrastructure is maintained during a wildfire.

Additional Mitigation and Risk Considerations

Sprinklers

The use of sprinklers for interface structure protection can be logistically complex and time-consuming. They are not a guaranteed solution, but can be an important contribution to interface fire mitigation strategy. Typically, an interface home sprinkler system requires a large open water supply (almost 5,000 gallons for 1 hour of use). Federal support for the installation of sprinkler systems on CAFN government buildings and critical infrastructure may be available through Indigenous Services Canada’s Emergency Management Assistance Program (EMAP).

Chip and Haul Projects

In 2021, initiatives were piloted by WFM to encourage homeowners and communities to reduce fuel hazards. These were trialled on the Whitehorse periphery and were very successful, facilitating the removal of more than 70 tons of woody debris from private properties in rural residential areas. Initiatives include free mobile brush-chipping services and removal. It is anticipated that there may be a broader roll-out of these initiatives in future, dependent on funding availability and community interest.

Figure 21. Example of a chip and haul initiative in the Whitehorse area.

Risk Management in Kluane National Park and Reserve

There are a number of preparedness and prevention measures in place to reduce the risk of human caused fires in the park. Measures in Kluane National Park and Reserve include, but are not limited to: forest fuel reduction/mitigation; targeted messaging to campsite users not to leave campfires unattended; use of temporary fire bans and area closures based on the fire danger indices; daily rounds/monitoring of all campsites at the Kathleen Lake campground; and daily monitoring of signs of fire through remote sensing (NASA satellite) to detect 'heat signatures' within the park and up to 5 kilometres from the park boundary.

Over the period from 2001 to 2020, there was, on average, less than one wildfire per year and the annual area burned was less than 0.1 hectares[17].

Building from decades of wildfire management experience and interim guidance, a Wildfire Management Plan for KNPR is under development.

Lessons Learned

Wildfires in recent years elsewhere in Canada, particularly B.C. and Alberta, have exhibited more extreme behaviour and impacts to community values than they have historically. There are lessons to be drawn from these fire events to better understand what were the conditions that led to the extreme fire behaviour and other factors that influenced the level of damage and destruction in order that other communities can avoid the same experiences.

There are lessons to be drawn from the fires in the boreal forests adjacent to Slave Lake, Alberta and the Wadin Bay and Weyakwin fires in northern Saskatchewan in 2015. However, the fire that is at the forefront of examples of extreme fire behaviour with a high community impact is the fire in Fort McMurray, Alberta. In early May 2016, a catastrophic wildfire in Fort McMurray, Alberta destroyed more than 2,400 structures and resulted in losses close to $10 billion. Heavy fire suppression over more than 50 years contributed to the development of even-aged mature conifers close to the community. A warm, dry spring influenced factors conducive to ignition. A case study of the impacts of the fire and the dynamics of fire behaviour was performed soon after the fire took place (Westhaver 2017). It

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17 Scott Stewart, Fire and Coordinator, Kluane National Park and Reserve, Parks Canada, Personal Communication.

was reported that almost all home ignitions would have been caused by embers from the fire and that there were no instances where home ignition was likely to have been caused by radiant heat or direct flames.

Results from the investigation revealed that those homes that survived the fire had low-to-moderate hazards and showed that FireSmart guidelines had been followed. Of the homes that survived, the following features were observed: uncluttered yards with few combustible materials and opportunities for ignition, and surface fuel with low flammability, such as a green lawn or no use of wood mulches (Westhaver 2017). A number of those homes that were destroyed, however, exhibited high-to-extreme hazard levels and were not considered 'Firesmarted' (Westhaver 2017).

> *There are enough parallel circumstances between the forest types and conditions present during the Fort McMurray fire and the conditions prevalent around Haines Junction to warrant consideration of the Fort McMurray experience in community preparedness and protection.*

5. Planning Considerations

Municipal Planning

Municipalities have the ability to enhance fire protection using a suite of tools, particularly through zoning and bylaws. For example, planning for future subdivisions should consider fire hazards prior to development. Established infrastructure should also consider fire risk whenever upgrades are required. The Canadian Standards Association has developed a new National Standard of Canada for 'Fire Resilient Planning, for Northern Communities S504:19'. This standard helps guide community developments and building standards with considerations for communities living in fire-prone ecosystems such as those in Yukon.

The risk that wildfire poses to the community is recognized in the Haines Junction Official Community Plan (2020). There is support for the FireSmart program in the OCP. To further strengthen support for FireSmart practices, the community would also benefit from the development of incentives or a bylaw that specifically addresses wildfire hazard reduction.

The OCP also speaks of the need to plan and prepare for environmental emergencies and, toward this end, to develop an Emergency Management Plan for better preparedness, including for ‘extreme weather events.’ The OCP states there is intent to develop an Emergency Operations Center or appropriate facility for use during an emergency.

The Village of Haines Junction has collaborated with CAFN, YG and Parks Canada in initiatives around the Haines Junction area to reduce human and naturally occurring fires. VoHJ has coordinated fuel abatement projects complementary to those of its partners and has been involved with the Government of Yukon’s FireSmart Funding Program since its inception.

Kluane National Park and Reserve

Wildland Fire Management and Parks Canada recognize the elevated fire risk and mutual responsibilities associated with the present fire danger in the area around Haines Junction and KNPR. The two agencies sought to formalize this recognition and their respective roles in 2020[18]. The formal arrangement outlines the relationship regarding fire detection, initial attack and fire suppression. There is a Fire Co-operation Zone which extends 20 kilometres on either side of the KNPR boundary, within which both agencies will cooperate and communicate in their fire management response. Activities such as fire detection and initial attack in this zone can be carried out by either WFM or Parks Canada.

6. Communications and Monitoring

Opportunities for Engagement

The success of the CWPP relies on the level of engagement of the community in their support of planning and implementation. A community that is engaged and informed on wildfire protection is one that can move forward with an understanding of fire risk and the need to manage that risk through prevention education, fuel treatments and reducing fire ignition potential around private property.

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18 Both parties signed a ‘Contractual Agreement Regarding Wildland Fire Management’ (2020).

Implementing specific CWPP activities requires that the community is well-informed of the reasons for, and the benefits of, specific mitigation activities. The following steps will assist towards this objective:

1. Make use of Wildland Fire Management's website as a go-to source of practical information in advance of, and during, the fire season.
2. Local wildfire risk is currently posted daily during the summer. It is also communicated through the WFM website. Priority mitigation measures that are being undertaken may also be posted through community websites.
3. Existing FireSmart strategies will be communicated to encourage property owner action. A volunteer local FireSmart representative can be recruited to fill this role.
4. Forest Management Branch may engage the forest sector to identify opportunities for mutually beneficial forest/fuel treatments.
5. Expand the roles of Wildland Fire Management and Parks Canada staff for public education initiatives.

Proposed community engagement and education activities should be reviewed and implemented as an ongoing initiative. The following resources can assist with the implementation of community education and outreach activities (see below):

- Work with the VoHJ Fire Department and Wildland Fire Management to host events that promote FireSmart principles, emergency preparedness, pre-fire season readiness and post-wildfire hazards.
- Continue (and increase) the use of local government newsletters, social media, webpages and radio to promote FireSmart principles.
- Work with local stakeholders and interest groups to carry out FireSmart activities.

Monitoring and Reporting

An annual Haines Junction CWPP meeting will be established with stakeholders to update progress from the previous year and to update on current and future projects. This meeting will allow consultation and input into these projects. The Haines Junction Forest Fuels Management Group will be meeting at regular intervals during the year to identify and to continue implementing fuel abatement projects aimed at community protection. Incorporated into annual reporting will be an annual meeting at a Village of Haines Junction Council meeting to update and discuss community wildfire protection.

The CWPP is a living document that is developed using the best understanding of fire hazards and behaviour, and wildfire community protection known at the time of writing. The knowledge base is anticipated to evolve, as will the requirements for protection and risk reduction against wildfire in the community of Haines Junction. The CWPP will have a review cycle of 10 years. During the interim, WFM will track new and relevant information to include in future revisions of the CWPP.

Glossary

Backburning – Setting fire between the edge of the fire and the control line to consume fuel in the path of the fire.

Blowdown – See Windthrow.

Butt rot – Rotting at the base of a tree, usually due to decay caused by advanced age or insect attack.

Coarse Woody Debris – Refers to deadwood larger than 7.5 centimetres in diameter and laying horizontally at 45 degrees or less.

Conifer – A group of trees that are softwoods. Conifers have year-round needles or scales (with some exceptions). Regeneration is typically through cones, which are made up of seeds.

Controlled burn – Also known as a prescribed burn, a controlled burn refers to a fire intentionally ignited to achieve certain management objectives. Burns are usually conducted during the shoulder seasons (spring and fall) when conditions are less volatile, as ground and fuel moisture content is higher. Strict criteria must be met in order to conduct a safe burn.

Deciduous – Trees that lose their leaves in the fall, such as aspen, poplar and birch are deciduous species.

Duff layer – A general term referring to the uppermost layer of the forest floor comprised of litter (usually leaves and small branches).

Firebrands – Refers to embers of flaming material that break off from burning vegetation or structures and are transported through the air.

Fire Break – A natural or constructed barrier used to stop or slow the speed of fires. Fire breaks can also provide a position (control line) from which to attack a fire.

Fuel – Refers to combustible material such as grass, leaves, ground litter, plants, shrubs and trees consumed by a fire.

Urban-Interface Zone – This zone is at a higher risk for destruction from wildfire. Large tracts of forests that are adjacent to combustible structures, such as private residences, are at the interface of where wildfires can most threaten rural communities.

Masting – Refers to the event of cones developing and shedding. Masting years for white spruce in the area appear to occur approximately every 7 years.

Prescribed burn – See controlled burn.

Regeneration – The renewal or regrowth of trees or a forest.

Stand – Refers to a forested area. For example, ‘a stand of spruce’ is a spruce forest.

Windrose – A graphic or diagram that shows the relative frequency and strength of wind from different directions

Windthrow – Refers to a tree or trees that were uprooted, toppled (leaning), felled or broken due to wind. It is also known as blowdown.

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Personal Communication

Uma Bhatt, Professor, Atmospheric Science, University of Alaska
Gabor Fricska, Service Liaison Meteorologist, Environment Canada
Chris Hunter, Ecosystem Scientist, Yukon Field Unit, Parks Canada
Piyush Jain, Research Scientist, Canadian Forest Service, Natural Resources Canada
Jen Schmidt, Assistant Professor of Natural Resource Management and Policy, University of Alaska
Scott Stewart, Fire Coordinator, Kluane National Park and Reserve, Parks Canada
Chris Stockdale, Fire Research Scientist, Canadian Forest Service, Natural Resources Canada
Ellen Whitman, Forest Fire Research Scientist, Canadian Forest Service, Natural Resources Canada
Caitlin Mader, Forest Disturbance Analyst, Canadian Forest Service, Natural Resources Canada
Carmen Wong, Ecologist Team Leader, Yukon Field Unit, Parks Canada
Martin Eckervogt, Volunteer Fire Chief, Village of Haines Junction Fire Department

Appendix A – Case Studies of Fuel Treatment Effectiveness

The following case studies each illustrate the effectiveness of different fuel treatments in the boreal forest. It is often the case that fuel treatments, such as thinning, are developed from a theoretical hypothesis. These case studies serve to provide real-world examples of how well fuel treatments worked as intended. There are, however, limitations to conducting prescribed burns to simulate natural fire conditions. Fuel treatments are often limited by their proximity to communities and infrastructure, and the associated safety and health concerns. There are logistical challenges on account of the short window available with fire weather conditions that allow for high rates of spread, but enough surface moisture to reduce fire intensity and, therefore, facilitate control of the test fire as needed (Beverly et al 2020).

The following four case studies were evaluated by Beverly et al (2020). A fifth wildfire was evaluated by FP Innovations (Ault et al 2017) and all provide practical insight into fuel treatments that can be applicable in a Yukon context.

Table 3. A summary of case studies of fuel treatment effectiveness.

1	(Alaska) Experimental Fire – Black Spruce and White Spruce	The effects on crown fire intensity from different fuel treatments in Alaskan boreal forest were assessed based on observations of fuel consumption, burn severity and fire behaviour during a 2009 prescribed fire. Fuel reduction treatments included pruning trees to a height of 1.2 metres. Stand density was reduced from 7,531 to 3,849 per hectare in control (natural stands) and reduced from 2,359 to 1,290 stems per hectare in thinned stands. Woody biomass from thinned stands were hauled offsite. A high-intensity crown fire (38,990kW/m) that occurred in a natural, untreated black spruce and white spruce forest was seen to transition to a surface fire within 30 metres of spreading into the thinned areas.

2	(Alberta) Experimental Fire – Black Spruce	In 2015, fuel treatment effects in black spruce were assessed at the Red Earth Creek experimental burning site. Fuel treatments (ie. thinning and strip removal) took place in 2013 and 2014. Stand density was reduced from 1,260 to 400 stems per hectare in thinned stands and reduced to 650 stems per hectare in strip-removed treatment. The woody waste was chipped and spread on site at an average rate of 2.67 kg/m2. A high intensity crown fire (13 – 27,840 kW/m) was ignited in nearby untreated black spruce under low fuel moisture conditions and relatively high winds to facilitate fire spread into treatment plots. Sustained crown fire spread was inhibited in the thinned stand. Observed fire behaviour correlates with the assertion that winds of 60 kilometres per hour are needed to sustain a crown fire in the thinned stand. The strip-treated area had a sustained crown fire spread. However, despite the apparent effectiveness of thinning, the majority of the trees had burned crowns due to candling. This would have been a source of aerial embers. Black spruce can be a major host of arboreal lichens. Along with feathermoss, lichens and the mulched chips were observed to be highly flammable when in contact with embers.
3	(Alberta) Experimental Fire – Black Spruce	In May 2019, a high-intensity crown fire was ignited in natural black spruce stands at the Pelican Mountain experimental site under extremely low fuel moisture conditions and high wind speeds (12 to 27 kilometres an hour). The fire spread into a stand that was thinned the previous winter. The rate of thinning was a reduction from 12,000 to 3,000 stems per hectare. It was noted that ground surface dominated by feathermoss has a markedly high rate of spread and fireline intensity. The ineffectiveness of the fuel treatment is thought to be because of the hand thinning taking place in winter that left surface fuel in place, as well as the surface fuel moisture being drier in the more open stand.

4	(Northwest Territories) Experimental Fire – Jack Pine	In 2005 and 2007, fuel-treated jack pine stands were burned at the experimental site in NWT. The fires were ignited in nearby, natural mixed jack pine-black spruce stands. Rates of spread in the treated stand were < 1 m/min whereas the natural areas had a rate of spread of 21 to 40 m/min. The extremely high rates of spread were thought to have occurred because of the abundant reindeer lichen.
5	(Saskatchewan) Wildfire – Jack Pine	The community of Weyakwin had a fire guard (504 metres long and 33 metres wide) on its eastern side and had conducted 4.6 hectares of thinning between the community and the fire guard in 2010 and 2011. Stand density was reduced from 3,119 stems per hectare to 987. In 2015, a wildfire affected the treated area. It was concluded that the treated areas allowed for less fire intensity and therefore ease of movement for fire crews and safer entry into the stand.

Kilograms per square metre (kg/m2) is a measure of the weight of forest fuel per square meter of space.

Kilowatts per metre (kW/m) represents the rate of energy or heat release per unit time per unit length of fire front. Simply put, kW/m is a quantified value of the fire intensity.

Appendix B - Maps of Haines Junction Exposure (Risk of Ember Transport)

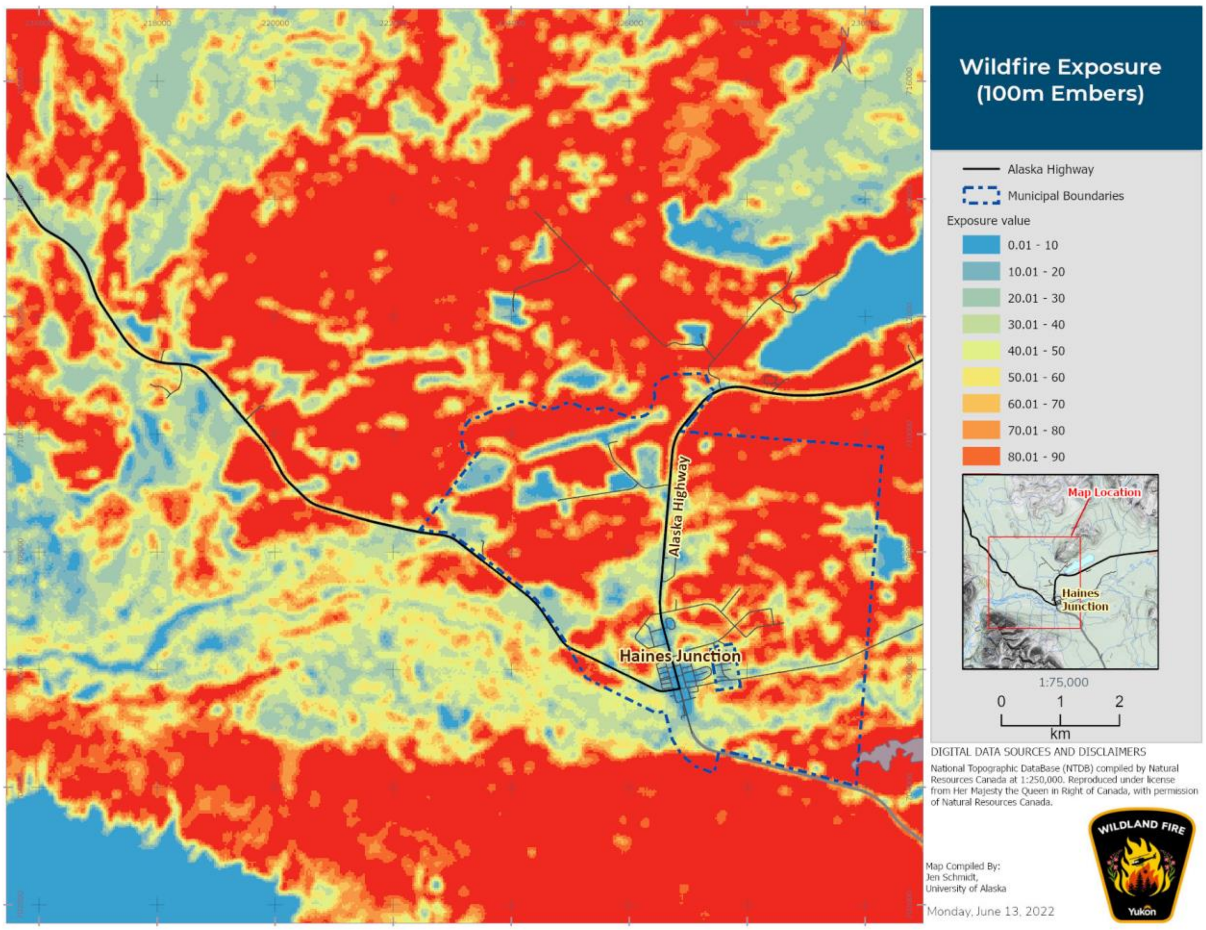

Figure 22. Exposure Map of Haines Junction – 100 metre Ember Transport

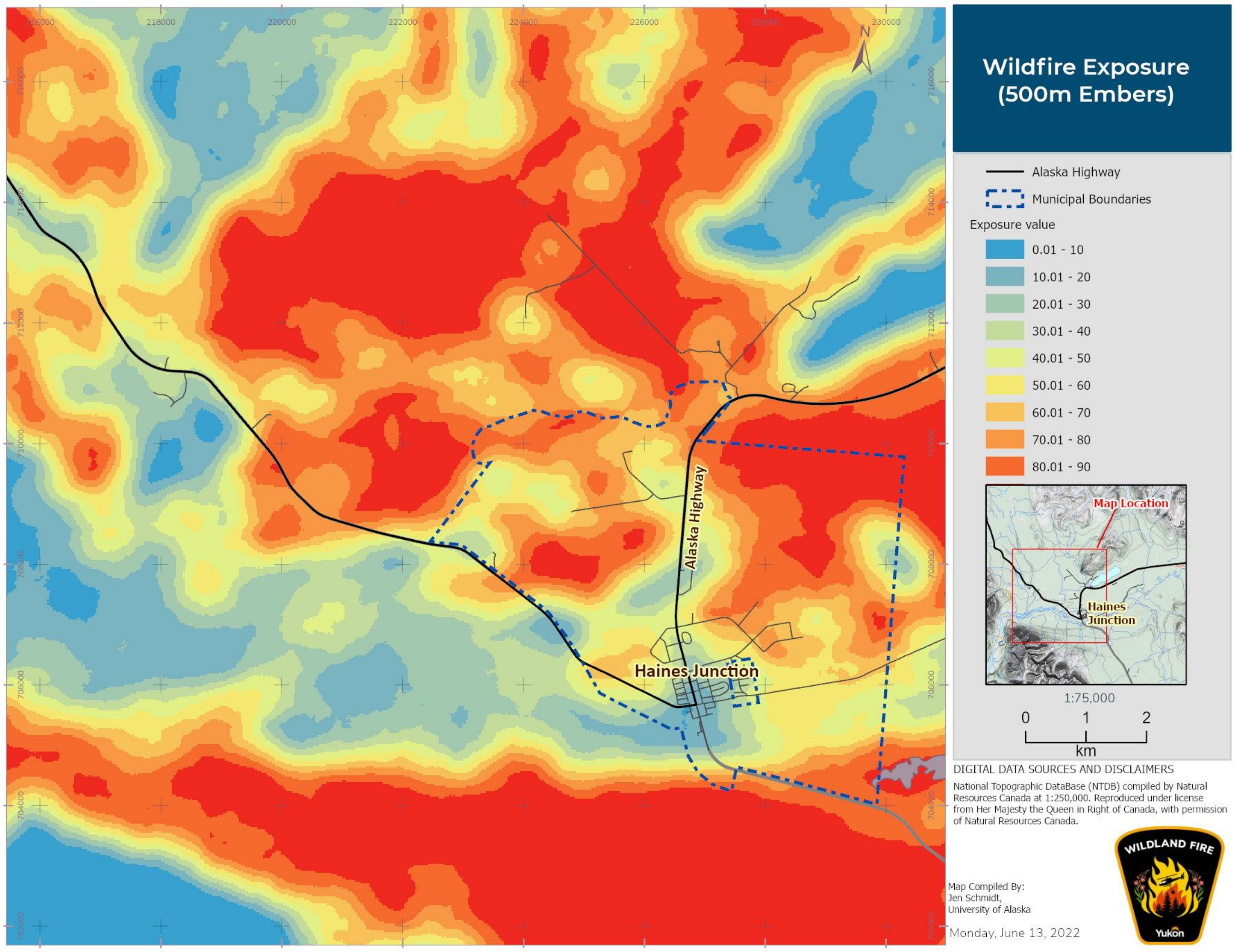

Figure 23. Exposure Map of Haines Junction – 500 metre Ember Transport

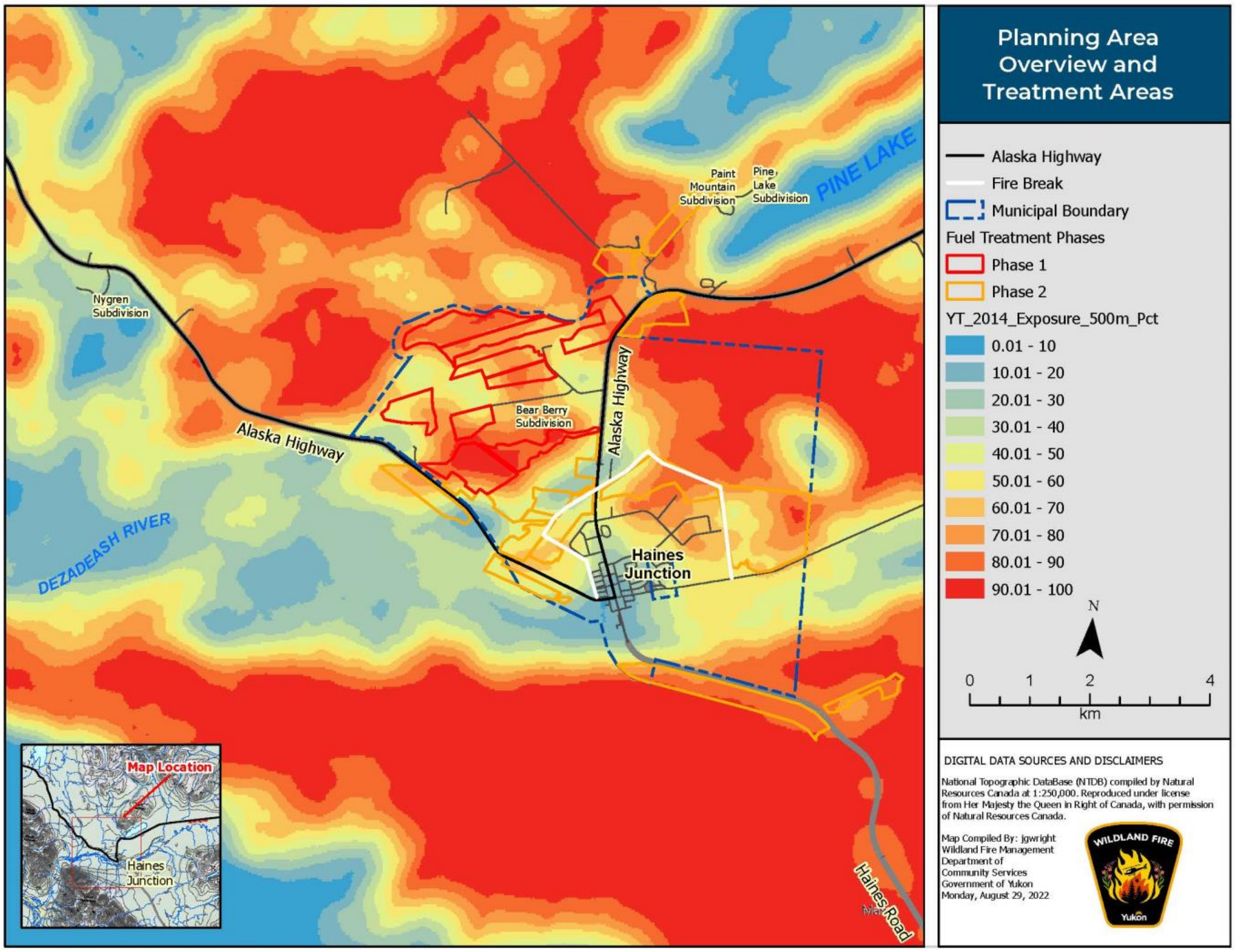

Figure 24. Fuel Treatment Phases and Exposure Map of Haines Junction – 500 metre Ember Transport

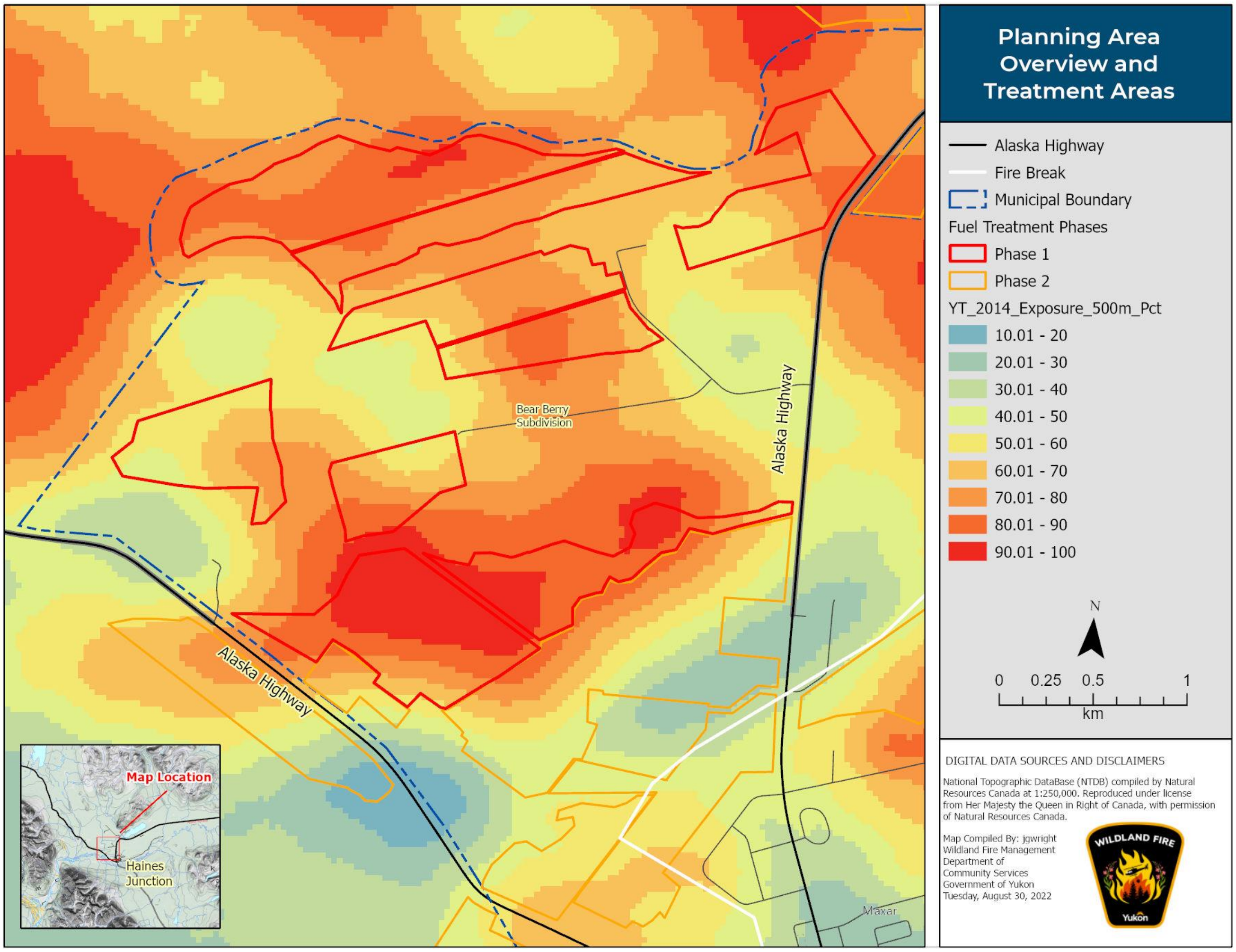

Figure 25. Fuel Treatment Phase 1 and Exposure Map of Haines Junction – 500 metre Ember Transport

Appendix C - Recent Natural Disturbance adjacent to Haines Junction

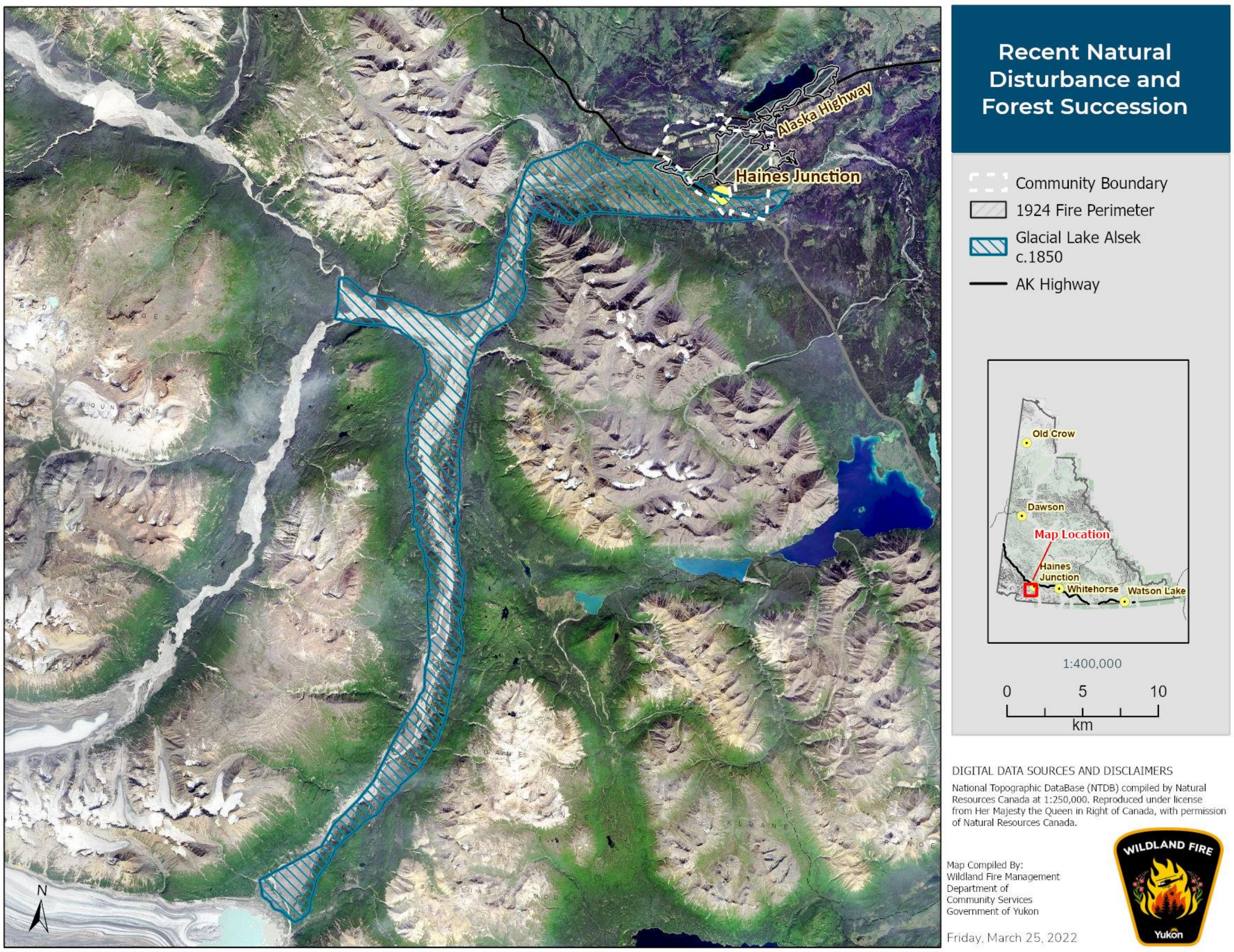

Figure 26. Recent Natural Disturbance: Lake Alsek and the 1929 Fire.